Compress

SEPTEMBER 1951

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LITERATURE

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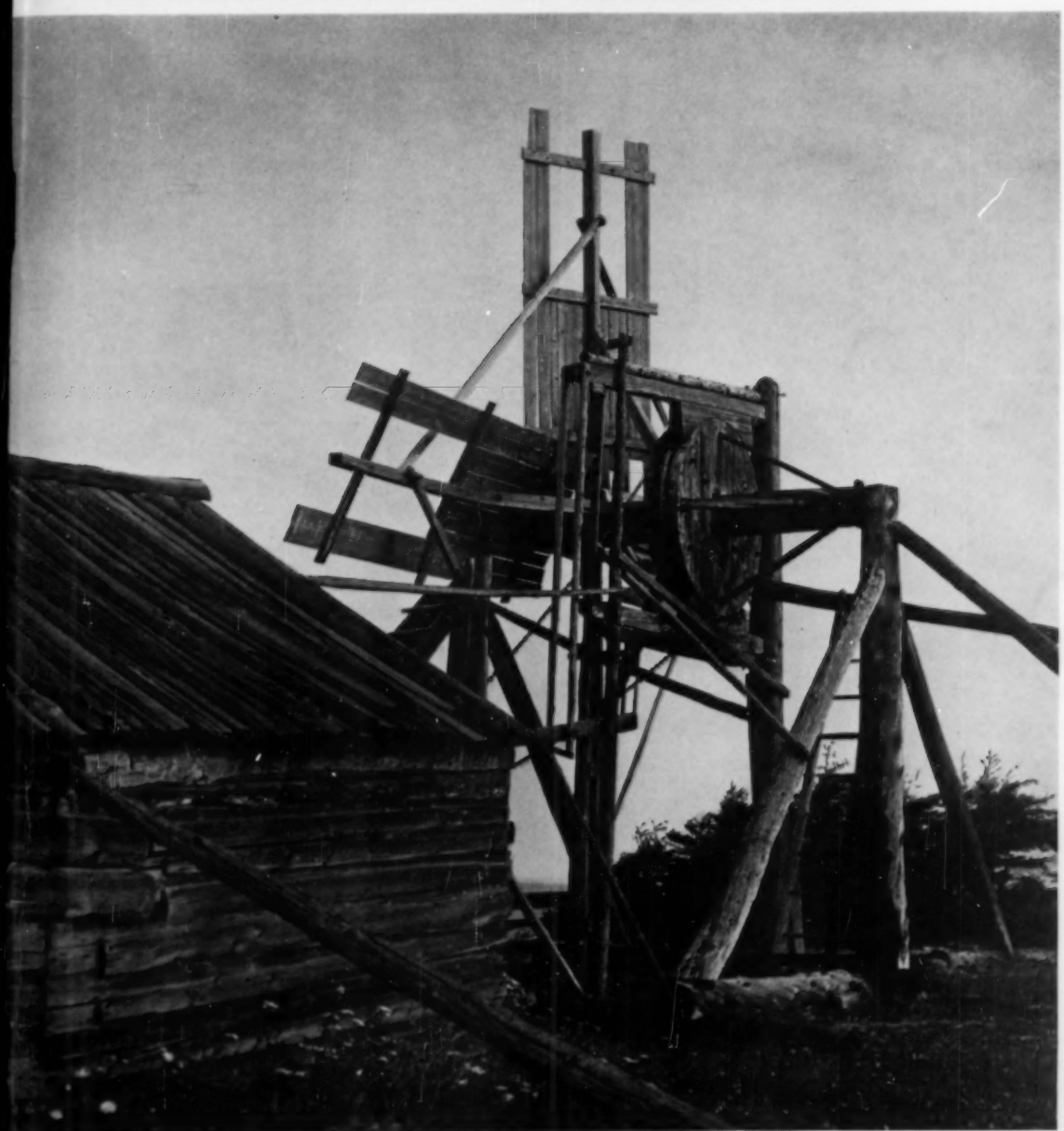


ONTARIO DEPARTMENT OF LANDS AND FORESTS

STILL IN SERVICE AFTER 81 YEARS

Wooden windmill in Canada drives modern saw in small lumber plant

(SEE INDEX PAGE)

VOLUME 56 • NUMBER 9

NEW YORK • LONDON

Down time due to FOUL AIR adds more to your costs...

... than the blower that helps men do a fair day's work

Speed fresh, cool air into a furnace, manhole, tank or other confined area where men must work and you'll get faster, better work in return.

There's a portable, easily adaptable Coppus Blower or Exhauster for just about any problem caused by stagnant, hot or fume-filled air. The Blue Ribbon stands for precision engineering that assures peak performance at lowest cost. Check and mail the coupon today for the information that fits your particular problem. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, BEST'S SAFETY DIRECTORY, MINING CATALOGS.

OTHER COPPUS "BLUE RIBBON" PRODUCTS

HORIZONTAL TURBINE
Six frame sizes —
1 to 150 horsepower

VERTICAL TURBINE
Six frame sizes —
1 to 150 horsepower

FANMIX GAS BURNER

FANMIX OIL BURNER

MAIL THIS COUPON To Coppus Engineering Corp., 209 Park Avenue, Worcester 2, Mass.

PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets; etc., after treated with coating material.

NAME .....

COMPANY .....

ADDRESS .....

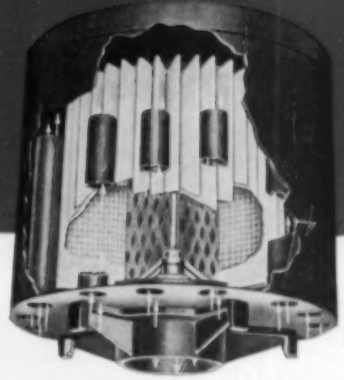
CITY .....

(Write here any special ventilating problem you may have.)

IT FILTERS!

IT SILENCES!

CUTAWAY VIEW



STAYNEW MODEL DS INTAKE FILTER

Both silencing and filtering in a single compact unit! All the outstanding advantages of the original Staynew Dry-Type Radial Fin Construction: low resistance to air flow; increased efficiency with use; suitability for use on carbon ring compressors; no oil, viscous coating or charging tanks; no moving parts; inserts easily and inexpensively cleaned or replaced.

Silencing is efficiently handled without excess back pressure thru a series of cylindrical rectifying chambers of scientific diameter to length ratio.

Thousands of these well-designed, well-built Staynew Filters are already in use, saving wear on compressor and internal combustion engines, reducing intake clamor.

FOR COMPLETE DETAILS WRITE:

DOLLINGER PROTECTO MOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

7 CENTRE PK., ROCHESTER 3, N. Y.

IN CANADA: Toronto - McCarthy and Robinson Montreal - Engineering Equipment Co. IN FRANCE: Paris - Société Tecalemit

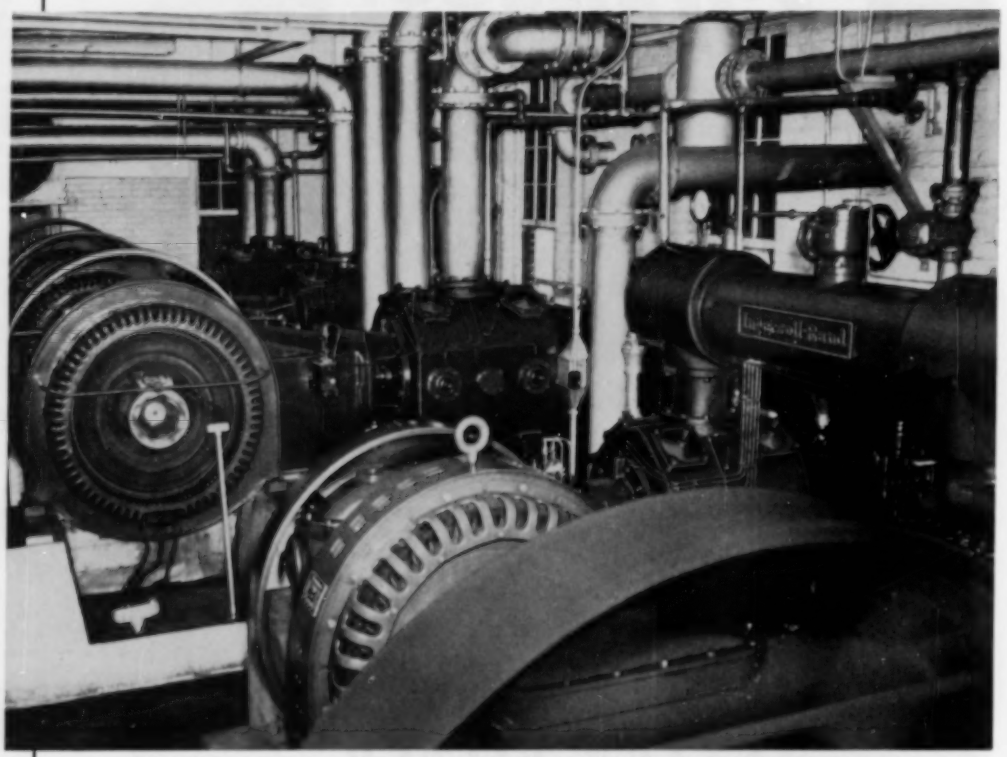
Some of the things AIR POWER is doing in Textile Mills

- AGITATE LIQUIDS
- MOVE SOLUTIONS BY DISPLACEMENT
- OPERATE HOISTS AND LIFTS
- CLEAN MACHINERY
- OPERATE AIR MOTORS
- CONTROL AUTOMATIC SPRINKLER SYSTEMS
- HUMIDIFY
- EVAPORATIVE COOLING
- OPERATE BALING PRESSES
- SPRAY LIQUIDS ON FIBERS AND CLOTH
- LOAD ROLLS BY AIR CYLINDER
- OPERATE PNEUMATIC TOOLS
- RAISE AND LOWER FOLDING MACHINE TABLES
- OPERATE CONTROL INSTRUMENTS
- OPERATE LAUNDRY-TYPE PRESSES
- OPEN AND CLOSE DOORS AUTOMATICALLY
- DEFLECT GOODS BY AIR JET
- CONTROL COMBUSTION IN BOILERS
- DO WOOL AND COTTON-ROLL PICKING
- DRY YARN
- CONVEY WOOL AND FIBERS
- DO VACUUM CARD STRIPPING
- MAINTAIN NYLON THREAD TENSION BY AIR JET
- OPERATE AIR CLOTH GUIDES

for dependability and low cost

It's I-R *for* AIR POWER

at Exposition Cotton Mills



Part of the compressor room at Exposition Cotton Mills, showing the 125-horsepower XRE two-stage 100-psi compressor (foreground) and three of the four 125-horsepower ES single-stage units, equipped with 3-step clearance control for maintaining 30-psi pressure within a 2-psi range.

It takes a lot of *air power* to operate a big, modern textile plant like the Exposition Cotton Mills. The compressors that supply this air power must be able to stay on the job around the clock, day after day, year after year. Operating economy is mighty important, too.

That's why Exposition is so well pleased with the I-R equipment which supplies *all* of its air-power requirements. Four Ingersoll-Rand, ES compressors installed as part of Exposition's multi-million dollar modernization program were installed by the American Moistening Co. for the operation of evaporative cooling atomizing heads. These machines have *never* had an enforced shut-down. The same is true of the XRE compressor, installed in 1945, for general mill service. It has given approximately 50,000 hours of trouble-free operation.

Dependability like this—plus high operating efficiency and ease of inspection and maintenance—makes I-R compressors an excellent long term investment for any textile plant. Your nearest I-R representative will be glad to give you complete information on the right equipment for *your* air-power requirements.

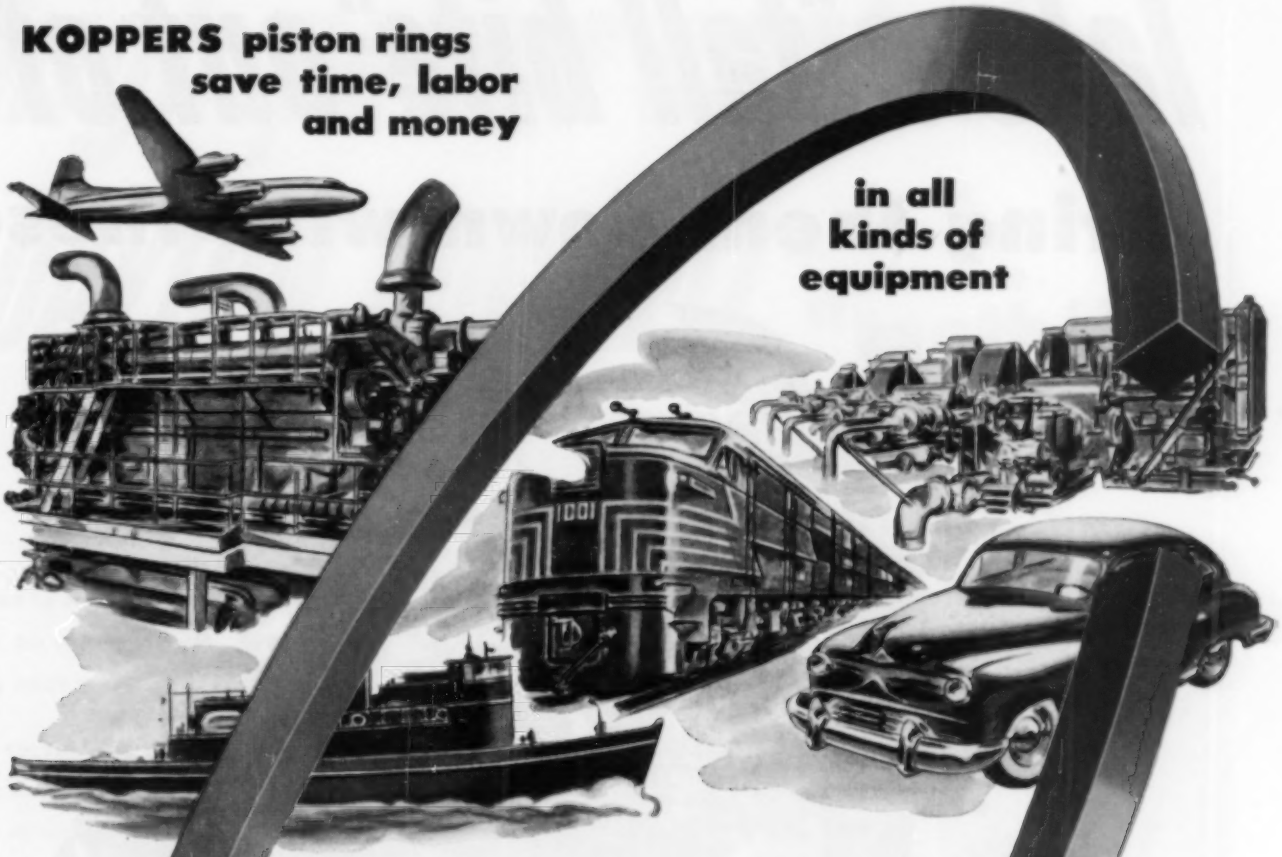
Ingersoll-Rand

11 Broadway, New York 4, N. Y. 656-1

COMPRESSORS • AIR TOOLS • ROCK DRILLS

TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

KOPPERS piston rings save time, labor and money



in all kinds of equipment

Railroads, trucks, buses, airplanes, cars, pumps . . . in every conceivable use of piston rings . . . Koppers provides *better* oil control, *more* power, *less* wear, *longer* life for expensive equipment!

Koppers K-Spun Piston Rings, produced by centrifugal casting process, are *100% stronger . . . four times more resistant to combustion shock than ordinary rings! They will not break in installation or for the life of the engine.*

Koppers Porous Chrome* Rings have a porous chrome surface that holds and distributes oil during break-in, quickly wears down to perfectly seated solid chrome that prevents grit and other particles from embedding in the ring surface where they can scratch cylinder walls. Porous Chrome Rings last up to four times as long as other rings, reduce cylinder wear 50% or more. That's why hundreds of companies are reporting amazing savings in equipment and maintenance costs through the use of Koppers Rings. Remember . . . we make rings for any equipment that uses piston rings.

*VAN DER HORST PROCESS

If you have a piston ring problem, why not get the *right* answer from us? Write, wire or phone Koppers Co., Inc., Piston Ring Dept., 1519 Hamburg St., Baltimore 3, Md.

KOPPERS

KOPPERS

AMERICAN HAMMERED

PISTON RINGS

SPECIFY: Fast's Couplings . . . Koppers Piston Rings . . . both famous products of the Koppers Co., Inc.

ONLY KOPPERS CAN FURNISH K-SPUN OR POROUS CHROME!

Take a "tall bite" out of

bring them down with these

V-Belts by

high power costs!

DAYTON COG-BELT* "teeth!"

40% MORE H. P. PER BELT **FEWER BELTS**
FEWER PULLEY GROOVES **LONGER BELT LIFE**

Want to save 2 V-Belts on every 7-belt drive, more on bigger drives? You can with the premium Dayton Cog-Belt because each belt delivers 40% more horsepower, as 5 Cogs do the work of 7 ordinary V-Belts!

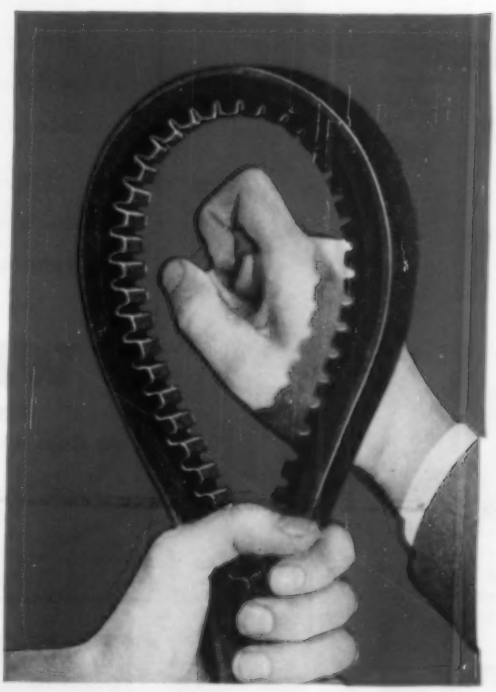
The reason: Cogs are the only V-Belt scientifically built to bend like your finger, for easy flexing, as the belt arches round pulleys. Compression strains are minimized, gripping power is increased. Cogs run cooler and last longer.

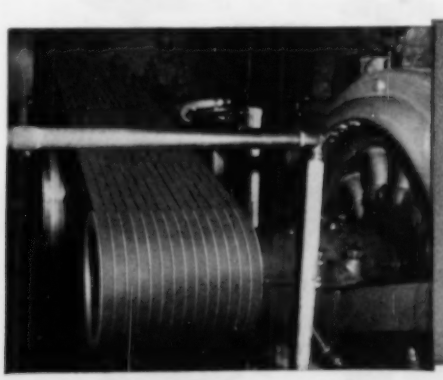
Want to save space? Cog-Belts let you use shorter center-to-center pulley distances—as much as 25% shorter.

Want to forget about V-Belts for the duration? Then convert to Cogs and their "40% Plus" performance, while you can. Give your Dayton Distributor the "high sign" of better power transmission—the arched finger that means Cog-Belt savings.

*T. M.

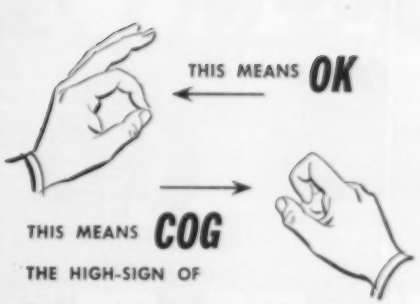
DAYTON RUBBER COMPANY • DAYTON 1, OHIO





COGS JOG GENERATOR!

A company making cheese boxes drives its plant generator with a 200 H.P. steam engine. The old flat-belt, countershaft drive never delivered enough h.p. to get maximum output from the generator. The Dayton Distributor sold them on converting to a Cog-Belt V-flat drive, direct to the generator. Now, the new drive delivers *more* h.p., at *slower* engine speed, with *less* fuel consumption, and—gets *maximum output* from the generator!



Dayton Rubber

WORLD'S LARGEST MANUFACTURER OF V-BELTS

Walworth manufactures a *complete line* of Gate, Globe, Angle, Check, and Lubricated Plug Valves, made of Stainless Steel, Steel, Iron, Bronze, and Special Alloys in a wide range of sizes and temperature-pressure ratings.

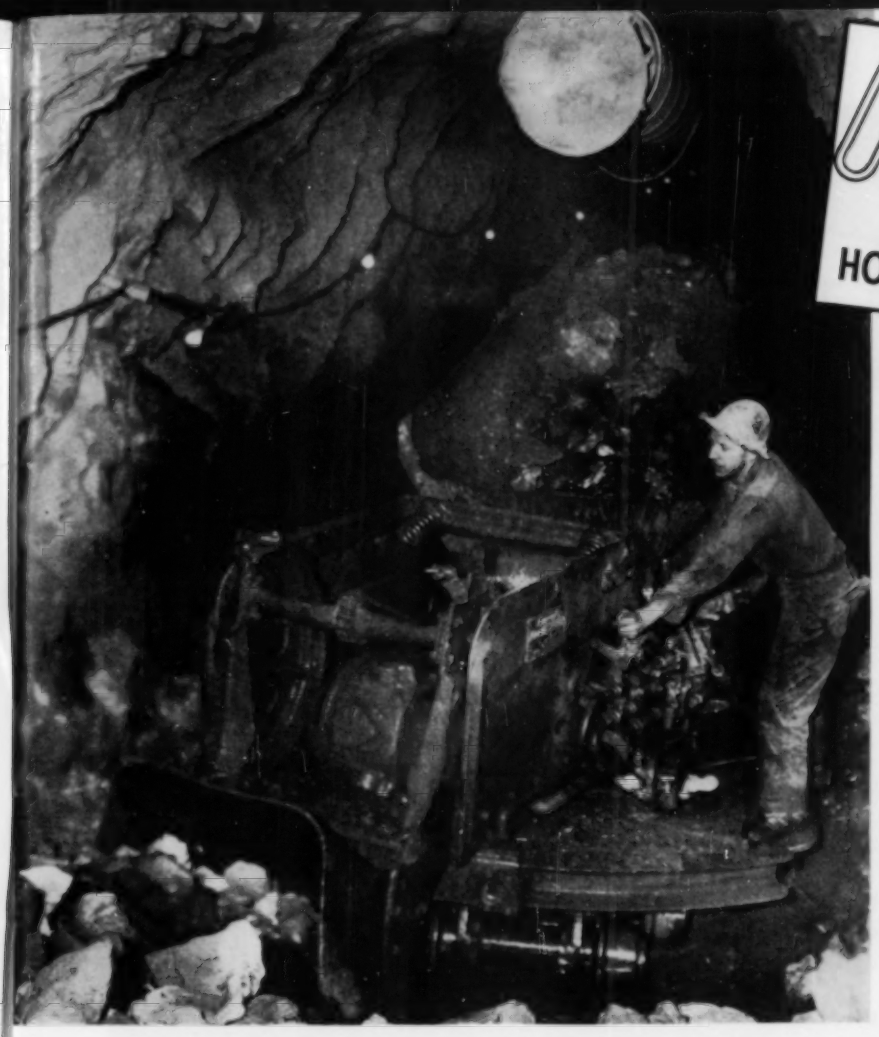
Fittings of steel, iron, and bronze are also manufactured in all conventional types and sizes.

WALWORTH

valves and fittings

60 East 42nd Street, New York 17, N. Y.

Distributors in principal centers throughout the world



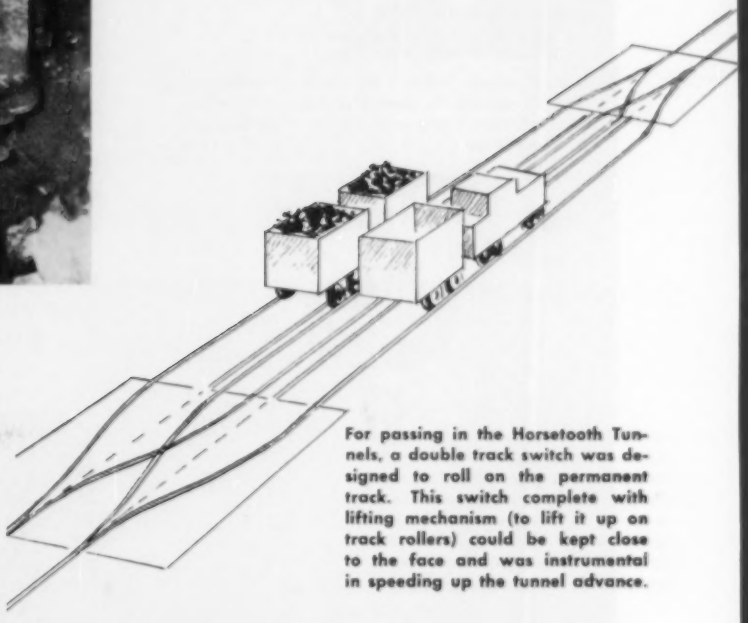
CASE HISTORY OF A SUCCESSFUL TUNNEL JOB

FROM THE EIMCO FILE T181

HORSETOOTH FEEDER TUNNEL

Specifications

Tunnel size 12′ x 12′. Total length (4 tunnels) approximately 15,000 ft. Longest tunnel 9500 ft. Best daily advance 72′. Average depth of round 7½ ft. Average advance per shift 14′9″. Average loading time 40 minutes. Loading machine—Eimco 40H.



For passing in the Horsetooth Tunnels, a double track switch was designed to roll on the permanent track. This switch complete with lifting mechanism (to lift it up on track rollers) could be kept close to the face and was instrumental in speeding up the tunnel advance.

Rock loading equipment must be made heavy-duty to withstand the shock and abrasion to which it is constantly subjected. For rock-loading underground, the equipment must not only be heavy-duty but it must be absolutely dependable.

Eimco's loading equipment is designed and built by men who have intimate knowledge and experience with rock handling conditions in remote and inaccessible places where breakdowns can mean job stoppage.

Each Eimco RockerShovel reflects this understanding of operational conditions. Each RockerShovel is made to stay on the job under the most trying conditions and for continuous, round the clock operation.

Thousands of these machines, in operation every day, in all the United States and fifty-three foreign countries have won the respect and admiration of all who use them.

That is why the great majority of metal mines have standardized on Eimco Rock-Loading Machines.

A241

EIMCO

THE EIMCO CORPORATION

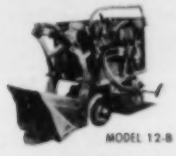
The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES – SALT LAKE CITY 10, UTAH, U. S. A.

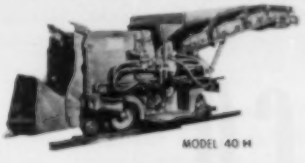
BRANCH SALES AND SERVICE OFFICES:

NEW YORK, 51-52 SOUTH STREET • CHICAGO, 3319 SOUTH WALLACE STREET
BIRMINGHAM, ALA., 3140 FAYETTE AVE. • DULUTH, MINN., 216 E. SUPERIOR ST.
EL PASO, TEXAS, MILLS BUILDING • BERKELEY, CALIFORNIA, P. O. BOX 240
KELLOGG, IDAHO, 307 DIVISION STREET

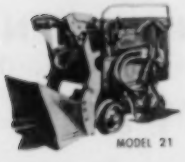
IN FRANCE: SOCIETE EIMCO, PARIS, FRANCE
IN ENGLAND: EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND
AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD



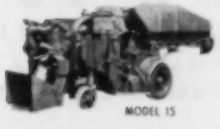
MODEL 12-B



MODEL 40 H

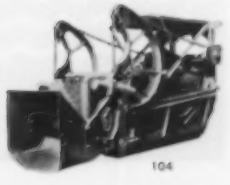


MODEL 21

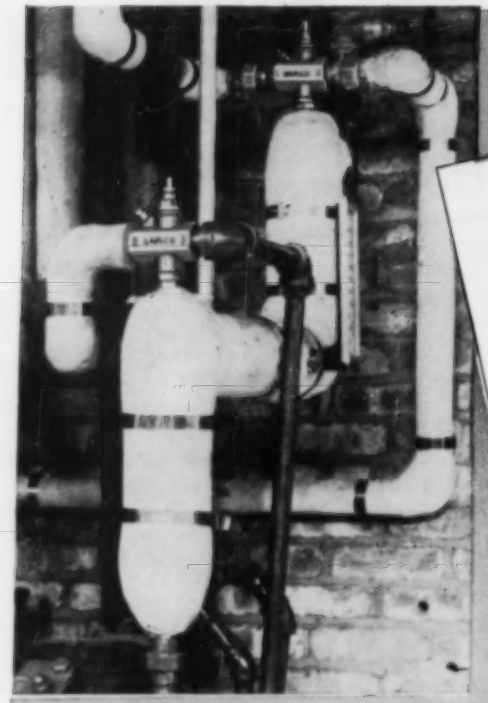


MODEL 15

102

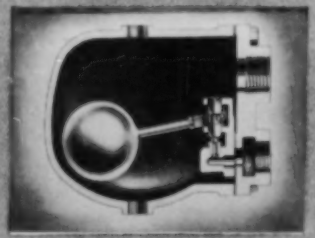


104



Sarco makes simple, self-acting temperature controls assuring the desired Jacket cooling effect with minimum water consumption regardless of load variations.

Sarco type TR-40-L Cooling Control-Jacket water temperatures never too hot or too cold.



Sarco type FA Drain Traps have four pressure ranges to 750 psi. Sizes: ¾" or 1".

IS YOUR AIR COMPRESSOR CAPACITY EFFECTIVE?

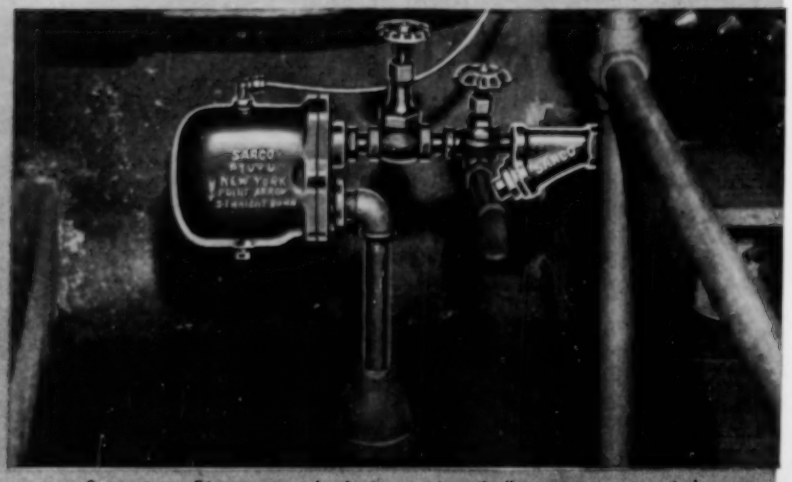
The true measure of effective air compressor capacity is the useful work done by your compressed air.

Measured by this yardstick, many compressor installations are very much oversize for the work they do.

Apart from poorly designed piping, the trouble usually lies in wet air, overcooling, undercooling, choked intake filters, etc. All of these things add up to expensive compressed air and high maintenance costs.

New Technical Bulletin, No. 5-CA, is designed to help users and would-be users of compressed air to get more work from their machines at less cost.

Write for your free copy today.

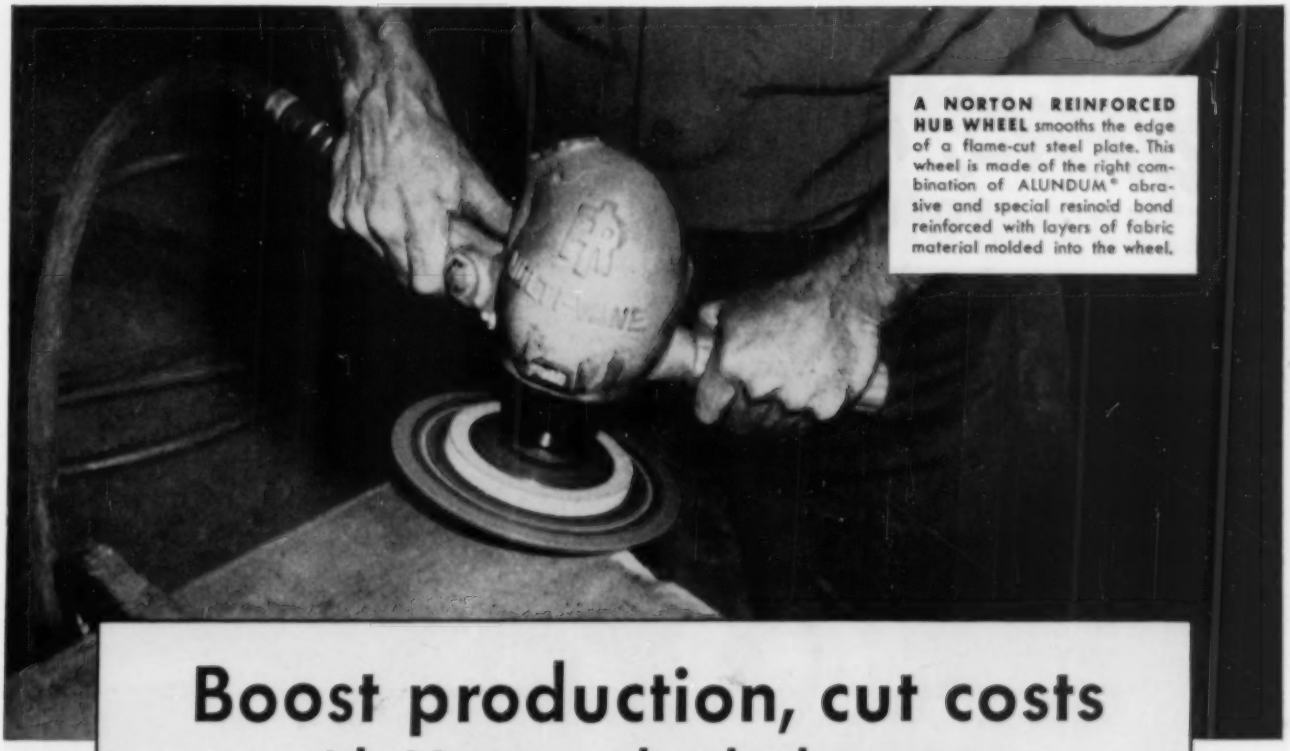


Sarco type FA compressed air trap automatically removes separated water from the bottom of the receiver. This greatly reduces the possibility of water being carried down the distribution lines to cause trouble in the tools or at the air nozzles. This trap is also used to drain water from separators and the low points of distribution lines.

343

SARCO COMPANY, INC.
EMPIRE STATE BUILDING, NEW YORK 1, N. Y.

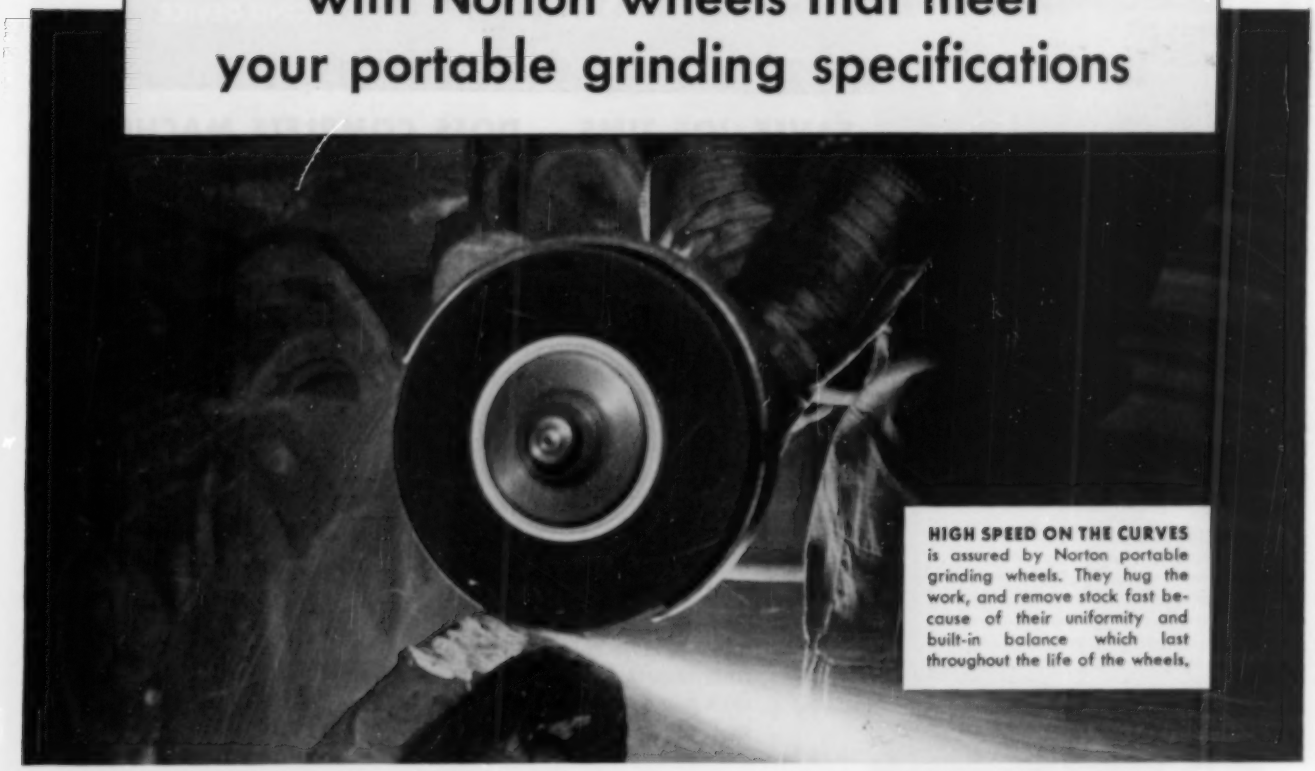
Represented in Principal Cities
SARCO CANADA LTD., TORONTO 5, ONTARIO



A NORTON REINFORCED HUB WHEEL smooths the edge of a flame-cut steel plate. This wheel is made of the right combination of ALUNDUM* abrasive and special resinoid bond reinforced with layers of fabric material molded into the wheel.

Boost production, cut costs

with Norton wheels that meet your portable grinding specifications



HIGH SPEED ON THE CURVES is assured by Norton portable grinding wheels. They hug the work, and remove stock fast because of their uniformity and built-in balance which last throughout the life of the wheels.

You can depend on the *right* wheel for the job when you choose Norton portable grinding wheels. There's a cup, cone, plug, or mounted point for every radius . . . all with the built-in balance that insures better grinding at lower cost. You get a wide selection of conventional type wheels plus the Norton *Reinforced* Hub Wheel . . . the safest, most durable wheel of its kind in the field. For complete information, ask your nearby Norton distributor or abrasive engineer for Form 1405 — a 54-page illustrated booklet on rough grinding. Or write us direct.

NORTON COMPANY
WORCESTER 6, MASS.
Distributors In All Principal Cities

NORTON
ABRASIVES

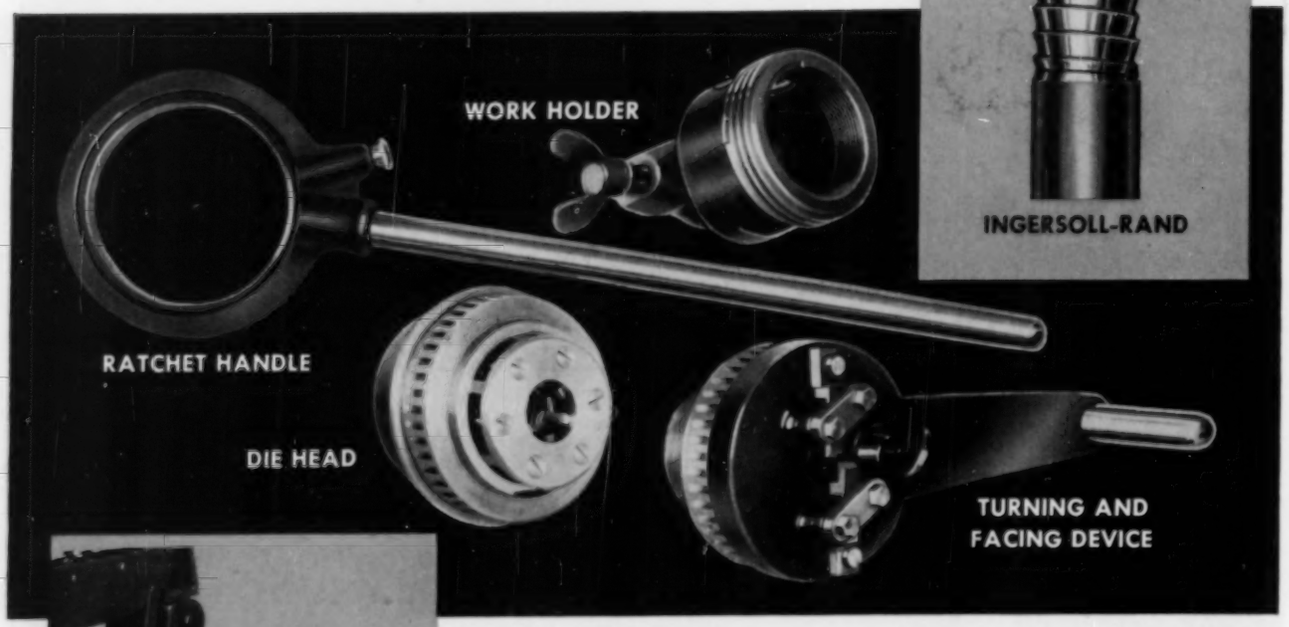
Making better products to make other products better

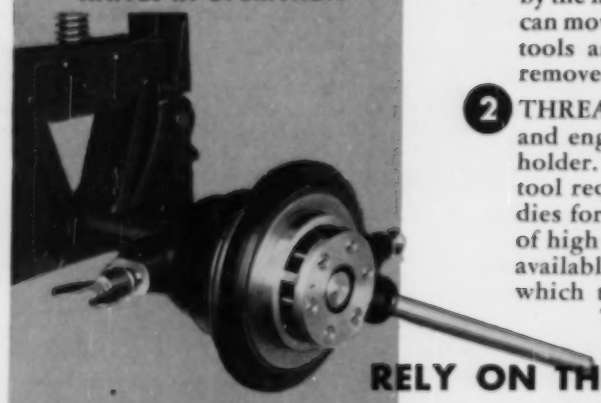
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

HAND OPERATED TOLEDO TOOL

TURNS, FACES, THREADS

ROCK DRILL RODS!





SAVES JOB-TIME... DOES COMPLETE MACHINING

This sturdy Toledo hand-operated Tool will turn, face and thread the ends of rock drill rods for Ingersoll-Rand detachable bits . . . produces threads 00, 0, 1, 2, or 3 (4 threads per inch left hand). Works easily and will produce a finished rod equal to any turned out by a lathe or other power machine. The tool consists of four main parts as shown above.

1. TURNING AND FACING. The work holder is clamped on the rod and serves as a support for both the turning and facing device and the die head. It remains in one position until all the work is done. The turning and facing device carries four turning tools which turn the rod to correct size. They are operated by the large ratchet handle. The front part of this device (which can move independently of the turning tools) carries the facing tools and is operated by the short handle. This device is removed when turning and facing are completed.

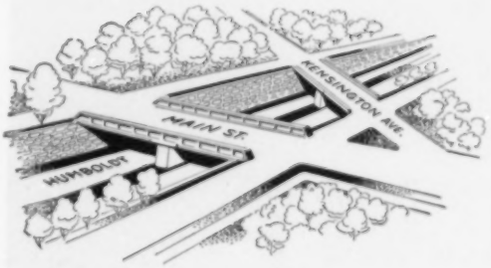
2. THREADING. Die head is placed on turned and faced rod and engaged with large left hand thread on outside of work holder. Die head is operated by large ratchet handle. Each tool requires separate set of turning tools and separate set of dies for each size and type of thread. All tools and dies made of high speed steel . . . easily removable for regrinding. Also available—No. 62 hand-operated Rock Drill Threading Tool which threads only. Write for bulletin. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

RELY ON THE LEADER...

TOLEDO

FOR ROCK DRILL ROD TOOLS

70,000 Cubic Yards of Rock Blasted to Underpass Busy Buffalo Intersection



When three busy traffic arteries intersect there's bound to be a problem. Relief for one such situation is now under way in Buffalo. Main Street and Kensington Avenue are being underpassed by a four-lane, divided stretch of Humboldt Parkway about six blocks in length. This $2 million project will speed the flow of traffic and greatly reduce noise and confusion, as well as enhance the neighborhood.

The contract, awarded to Brunner Brothers, of Buffalo, by the New York State Department of Public Works, calls for 70,000 cu yd of rock excavation and about 7000 cu yd of trench and culvert work. Edward A. Besch & Sons, also of Buffalo, is the sub-contractor for all rock removal. Drilling and blasting right through the winter months, the contractors have relied exclusively on Bethlehem Hollow Drill Steel to bore about 150,000 ft of hole in hard, flint-streaked rock.

This chilly scene in February shows the wagon drills running full tilt as Bethlehem Hollow Drill Steel bites through hard gray lime in the initial stages of the excavation work.

Edward Penkalski and Charles Besch of Edward A. Besch & Sons, of Buffalo, examine the carbide-tipped, detachable bits used on rods of 1¼-in. round Bethlehem Hollow Drill Steel. Holes range up to 15 ft in depth. This project is scheduled for completion in December, 1951.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM HOLLOW DRILL STEEL

Protect Air-operated Equipment Against Moisture and Dirt

The positive way to remove moisture and dirt from compressed air lines is to use the Cuno MICRO-KLEAN Air Line Filter.

This unique cartridge-type filter removes all entrained moisture, plus all foreign particles (dirt, pipe scale and other trash) down to 1 micron in size.

The dry, clean air assures more satisfactory performance—and longer life—of pneumatic tools, instruments, paint spray systems, hoists, etc.

Less Work for You

The Cuno MICRO-KLEAN Air Line Filter does its work with less attention required from you because its cartridge needs replacement only half as often.

The resin-impregnated fibres are non-wicking, so the trapped moisture drains promptly. The extra-large moisture-collecting area means less frequent draining.

Pressure drop across the cartridge is slight due to the openness of the structure—80 to 90% porosity—and to the absence of purely structural components (none needed) that offer resistance to flow.

A. Baffle deflects some moisture down outside cartridge.

B. Network of fibres catches remaining moisture and dirt as air works its way through interstices.

C. Trapped moisture drains into collection chamber.

Cuno Engineering Corporation
Dept. 177C, South Vine Street, Meriden, Conn.

Please send information on Cuno MICRO-KLEAN Air Line Filter for .....

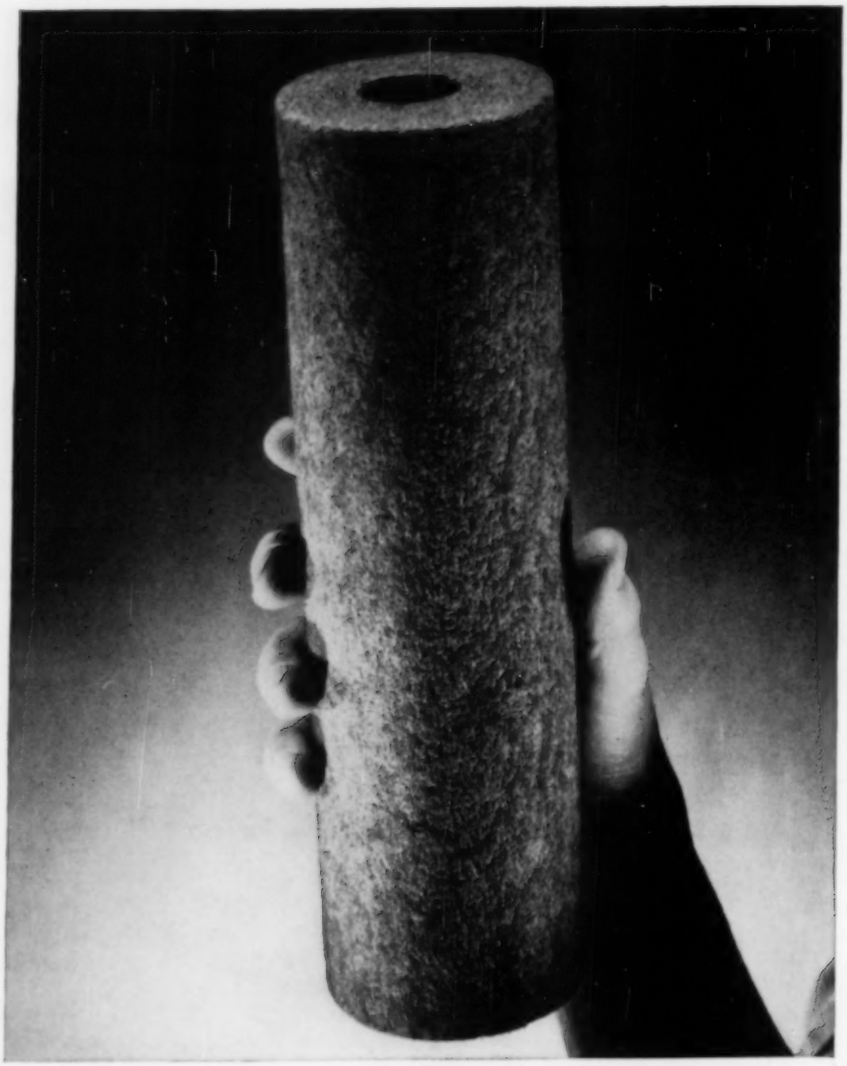
Name .....Title.....

Company .....

Address .....

City .....Zone....State....

Please attach to your business letterhead



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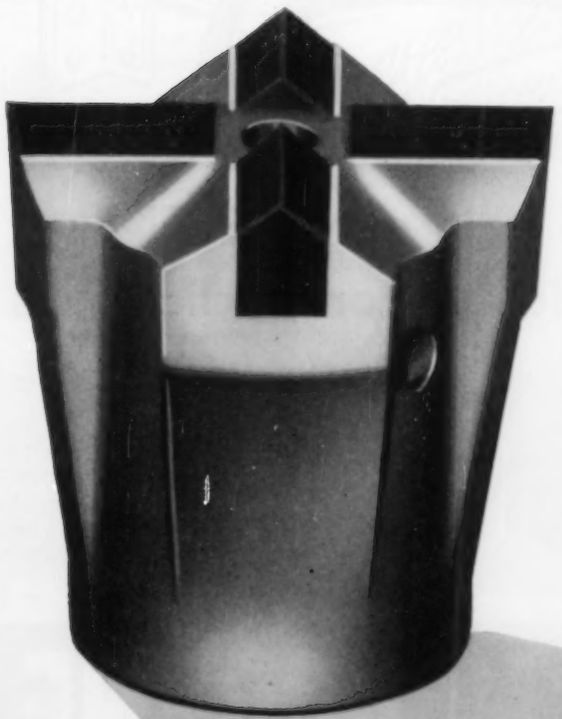

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Air hose, with cover and tube of Du Pont neoprene, has built up an enviable record for long, dependable service. Wherever it's used, neoprene hose stays on the job delivering maximum efficiency at minimum cost.

NEOPRENE PREVENTS TROUBLE LIKE THIS!

Jackhammer, partially dismantled, shows accumulation of disintegrated hose which has almost clogged up air ports in the valve and rifle bar assembly.

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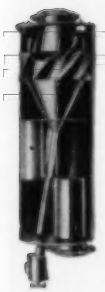

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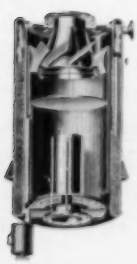

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. . . produce fresh water to a purity of 3½ parts per million from sea water — capacity smallest unit 350 gals. per day. ALL MONEL, high circulation rate means minimum scaling.

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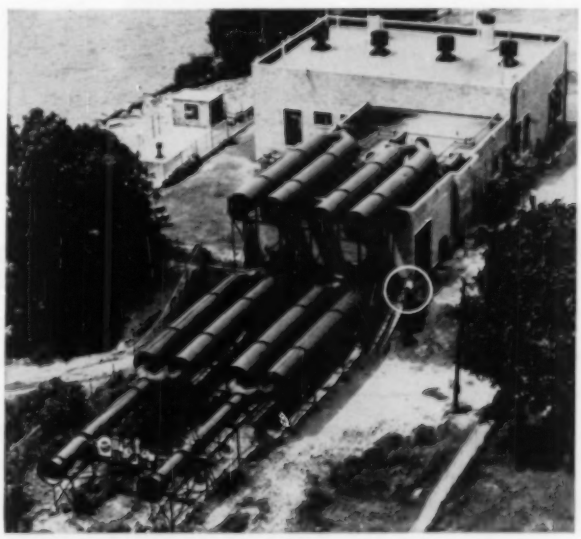

These big Maxim Silencers (note size of man in circle) quiet the scream of centrifugal compressors on test stands . . . a tough silencing job that Maxims are handling with quiet efficiency.

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Old-timer Nick Pezzente says:

"hard rock, high air pressure, round-the-clock operation calls for

CRUCIBLE HOLLOW DRILL STEELS!"

That's Nick Pezzente, Blaster, Slattery Contracting Company, Inc., tapping a charge in the big hole for the new Chrysler Building Annex in New York City. Slattery Contracting does a major portion of the rock work around the New York metropolitan area, and Nick's an old hand at knowing by experience what it takes in drill steel to do the best job at *lowest cost per foot drilled*. He's been in this business for more than 25 years.

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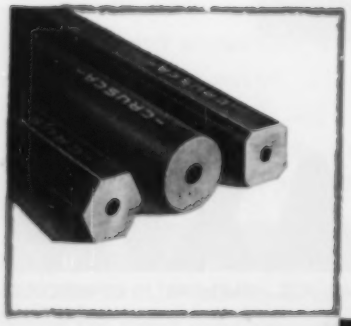

CRUCIBLE first name in special purpose steels

51 *years of* *Fine* *steelmaking* **HOLLOW DRILL STEEL**

HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

ON THE COVER

IN SPITE of Canada's wealth of hydroelectric power, the crude windmill pictured on the cover remains in service, turning a modern circular saw to produce a small quantity of lumber each day. The mill is located at a tourist-cabin camp near Cap de la Madeleine, close to the St. Lawrence River on the Gaspe Peninsula, Province of Quebec.

•

IN THIS ISSUE

MOST interstate natural-gas transmission lines carry fuel from the Southwest to the industrial and populous centers of the Midwest and East. Reversing this trend, El Paso Natural Gas Company, in conjunction with two California utilities, delivers it to the two largest Pacific Coast cities, Los Angeles and San Francisco. In addition, El Paso supplies gas to many communities in Texas, New Mexico, Arizona, and northern Mexico. Once it was able to get all the gas it needed from the oil fields of the Permian Basin, but as sales increased it ran a line northward to the Hugoton gas field in the Texas Panhandle. More recently, it reached farther north to tap the San Juan Basin fields of northern New Mexico and southern Colorado. All told, it now operates 5700 miles of line, constituting one of the nation's largest natural-gas networks. The story of El Paso's activities is told in our leading article.

•

A MAN with four or five hands could do a lot of work, but it is useless to think about it because Nature isn't going to change the human anatomy. Fortunately, the brain can think up ways to accomplish the same result and save a lot of manual labor to boot. One of the latest ideas is to combine from two to eight pneumatic nut runners and operate them as a single tool. Such machines are improving the quality of the work done on assembly lines and saving a lot of time as well. Page 235.

•

BECAUSE of the character of the work they do, airplane factories use air power extensively. For example, it takes nearly 6000 cfm of compressor capacity and 20 miles of air lines to serve the needs of a single plant on the Pacific Coast. Page 239.

•

WITH the nation girding for defense, lead and zinc are important metals. More of them will come from the historic Colorado camp of Leadville when the deep drainage tunnel being driven there by the U. S. Bureau of Mines is completed. Work on it was begun during the last war, suspended when funds gave out, and resumed in recent months. Water sufficient to supply a city of 25,000 persons is already flowing from the area perforated by the old mine workings.

•

CORRECTION

IN THE article, *Flame Spraying Plastics*, pages 209-10, August issue, it was stated that W. B. DeLong and E. V. Peterson, who developed special equipment used in the process, are with American Agile Corporation, of Cleveland, Ohio. Actually, both are with E. I. du Pont de Nemours & Company, Wilmington, Del.

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EDITORIAL CONTENTS

5700 Miles of Controlled Energy—*J. C. Pierce* 228
Running Two to Eight Nuts at a Time—*C. H. Vivian* 235
Twenty Miles of Air Lines 239
Leadville Drainage Tunnel 241
More Power at Niagara 243
Fairless Steel Works Rises 244
Editorials—Stockpiling—Flooded Areas Rebound—Exeunt Highgraders 246
This and That 247
Crusher Removes Carbon from Cloth 249
Nickel Company Forsakes Open Pits 249
Ropes Serviced in Motion 249
Industrial Notes 250
Books and Industrial Literature 254

ADVERTISING CONTENTS

Adams Co., Inc., R. P. 29
Air-Maze Corporation 38
Bethlehem Steel Company 13
Combustion Engineering-Superheater, Inc. 30
Compressed Air Magazine Co. 34
Cook Mfg. Co., Inc., C. Lee 28
Coppus Engineering Corporation 2nd Cover
Crucible Steel Co. of America 18
Cuno Engineering Corporation 14
Dayton Rubber Company, The 6, 7
Dollinger Corporation 3
Donaldson Company, Inc. 24
du Pont de Nemours & Co., Inc., E. I. 16
Eimco Corporation, The 9
Elliott Company 35
Fluor Corporation, Ltd., The 27
Galland-Henning Mfg. Co. 23
Goodrich Company, The B. F. 26
Hansen Manufacturing Co., The 32
Hunt & Son, Inc., C. B. 19
Ingersoll-Rand Company ..... 4, 15, 31 3rd Cover
Johnson Corporation, The 37
Koppers Company 5
Maxim Silencer Co., The 17
Naylor Pipe Company 20
New Jersey Meter Company 34
Niagara Blower Company 21
Norton Company 11
Nugent & Co., Inc., Wm. W. 37
Rucker Company, The 38
Sarco Company, Inc. 10
Sauerman Bros., Inc. 34
Square D Company 38
Terry Steam Turbine Co., The 33
Texas Company ..... Back Cover
Timken Roller Bearing Co., The 36
Toledo Pipe Threading Machine Co., The 12
Victaulic Co. of America 22
Vogt Machine Company, Henry 25
Walworth Company 8
Wisconsin Motor Corporation 37
Westinghouse Electric Corp. 39

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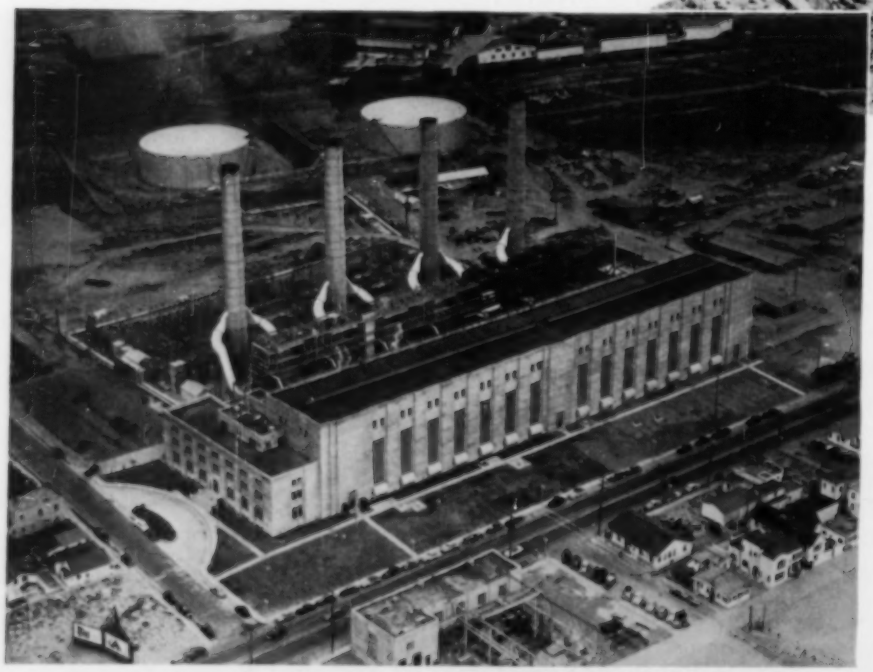
INDIAN TRADING POST

An El Paso Natural Gas Company plane at the Dilkon (Arizona) Trading Post 50 miles from a highway in the San Juan Basin country on the Navajo Indian Reservation. At posts like this the Navajo trades his sheep, wool, blankets and silverwork for the white man's goods that he needs. Dilkon means "smooth hill." Unlike the table-top protruberances and buttes with near-vertical sides so common on the reservation, the hill in the background served as an important landmark for the early Navajos.

5700 Miles of Controlled Energy

El Paso Natural Gas Company Operates a Far-flung Pipe-line System

J. C. Pierce

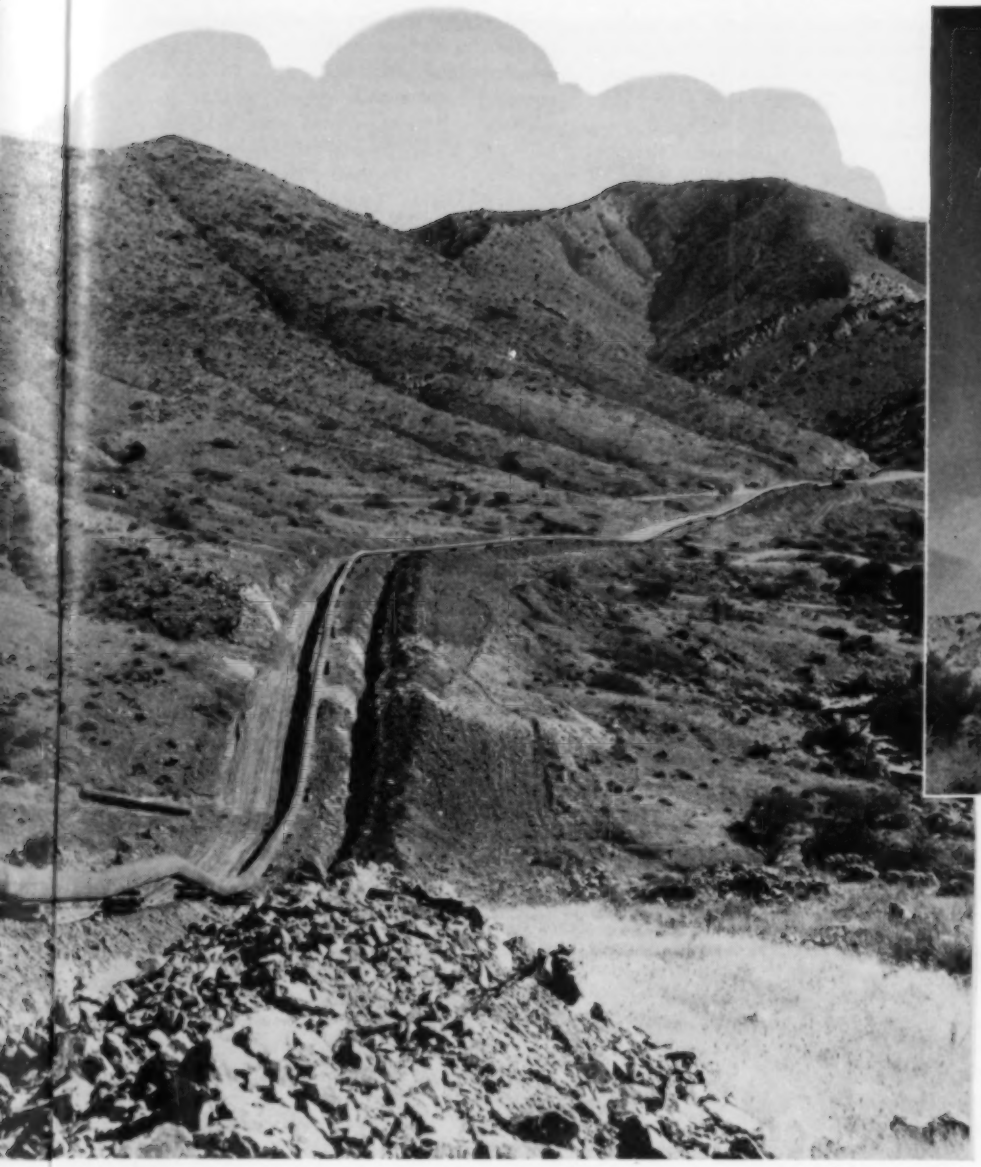


KILOWATTS FROM GAS

The Southern California Edison Company's Redondo steam generating station is one of the largest users of Texas-New Mexico natural gas. The plant contains four 70,000-kw generators and consumes about 3,300,000 cubic feet of gas per hour when operating at full capacity.

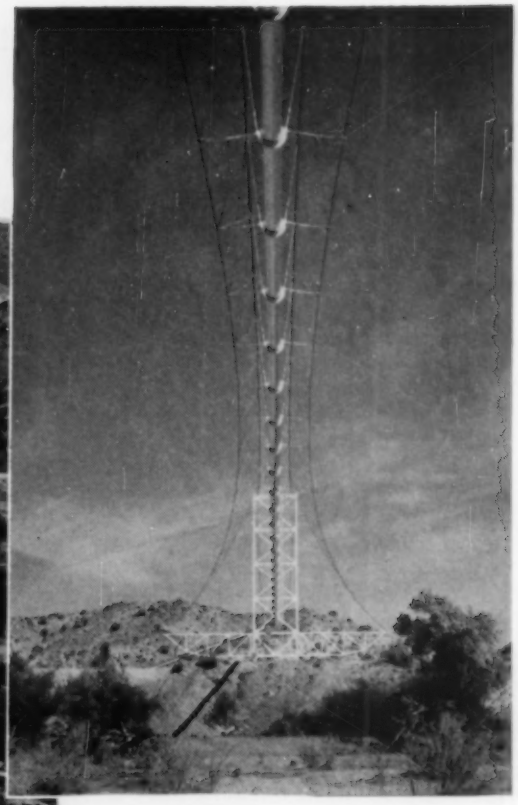
IT HAS often been said that the relative strength of a nation depends, among a host of other factors, upon its fuel supply. Certainly a country's sources of energy are all-important to its existence, and major developments in directing natural fuels from nature's storehouses to industries and homes are noteworthy. Harnessing a waste oil-well product to the wheels of industry and making it available so as to add to the comfort and convenience of homes throughout a vast area is the business of the El Paso Natural Gas Company.

Perhaps even the most optimistic dreams of the founders of El Paso Natural in the late 1920's failed to forecast the expanse of that company's present transmission network. A main-line pipe system ranging from 16 to 31 inches in diameter and extending from Dumas, Tex., to San Francisco, Calif., has grown out of the original 208 miles of 16-inch line connecting an oil field at Jal, in the southeastern corner of New Mexico,



TORTUOUS TUBE OF STEEL

A line constructed across the Apache Pass in Arizona. The pipe has been welded and is ready for priming (sometimes referred to as doping) and wrapping for corrosion resistance. That done, it will be carefully lowered into the ditch and covered with backfill.



BRIDGING A DRY RIVER

More than 3 miles of bridges, built at a cost of $4,000,000, carry the line over streams, some of which are dry or mere trickles except when occasional floods convert them into raging torrents. One of these is the Bill Williams River, shown here crossed by one of the system's fourteen suspension bridges. The 980-foot-long structure supports 30-inch piping.

with a few industrial installations and the then 100,000 people of El Paso, Tex. That initial investment of $6,000,000 in 1929 has mounted to $280,000,000 and represents 5700 miles of main and lateral pipe lines, treating and compressing plants and other assets. Three applications now before the Federal Power Commission provide for an expansion program that would raise the capital investment to $372,000,000, an increase of $92,000,000. Gas deliveries in 1950 totaled 237,348,210,000 cubic feet as against 5,406,672,000 in 1930.

Gas gathering extends from the original oil field at Jal through adjoining fields in the southeastern corner of New Mexico to west-central Texas—all known as the Permian Basin—and to the Texas Panhandle, or Hugoton Fields. Recently it has reached beyond into the San Juan Basin comprising a part of northwestern New Mexico and of southwestern Colorado.

Serving an area with a population of twelve million in west Texas, New Mexico, Arizona, northern Mexico and California, the El Paso Company does not retail gas but sells only to public utilities, either for distribution or for generating power, or to large industrial consumers who can take delivery outside of city limits. Breaking down its 1950 gross operating revenue of $39,952,024 we find that public utilities purchased 77.5 percent of the gas for resale for domestic, commercial and industrial use and for developing electricity; copper mines, smelters and refiners, 16.8 percent; other industrial customers, 1.8 percent; natural gasoline and by-products represent 3.2 percent and miscellaneous applications, 0.7 percent.

About half of the nation's copper production and more than 90 percent of its potash come from mines and plants which burn gas from the company's Southern Line. The Los Angeles industrial zone, served by two California distributors taking gas from the Southern Line terminus at the Arizona border, ranks among the country's top five city areas in value of products manufactured. The San Francisco industrial section, a big empire that is becoming more and more dependent upon Texas-New Mexico gaseous fuel, is supplied by the connected Southern and Northern lines, the gas being delivered by California's Pacific Gas & Electric Company.

It is estimated that three-fifths of all the natural gas used in the area covered by El Paso Natural Gas Company's system is supplied by it. Measured in terms of fuel value (Btu's), the amount consumed is severalfold greater than all the other energy available. Since the gas is delivered at about one-third the cost of any other fuel, the section involved is enjoying a saving

in industrial and home fuel estimated at $70 to $100 million a year.

El Paso Natural's contribution to the economic welfare of the Southwest and West Coast by reason of its gathering, treatment and transmission of natural gas is pinnacled by the contribution it makes to the nation in conserving and utilizing a natural resource. The gas from the Permian Basin and the Hugoton Fields is predominantly residue gas —a "sour, acid" by-product that is obtained in the production of oil and natural gasoline and that was almost entirely "flared" (burned at the well head to prevent air pollution) prior to 1942-43 owing to lack of a market. This "waste" gas, together with any dry or natural gas used, is now treated by the glycol-amine process to remove hydrogen sulphide, carbon dioxide and water. Thus converted into a superb 1100-Btu fuel, it is compressed for its journey westward through the pipe-line system.

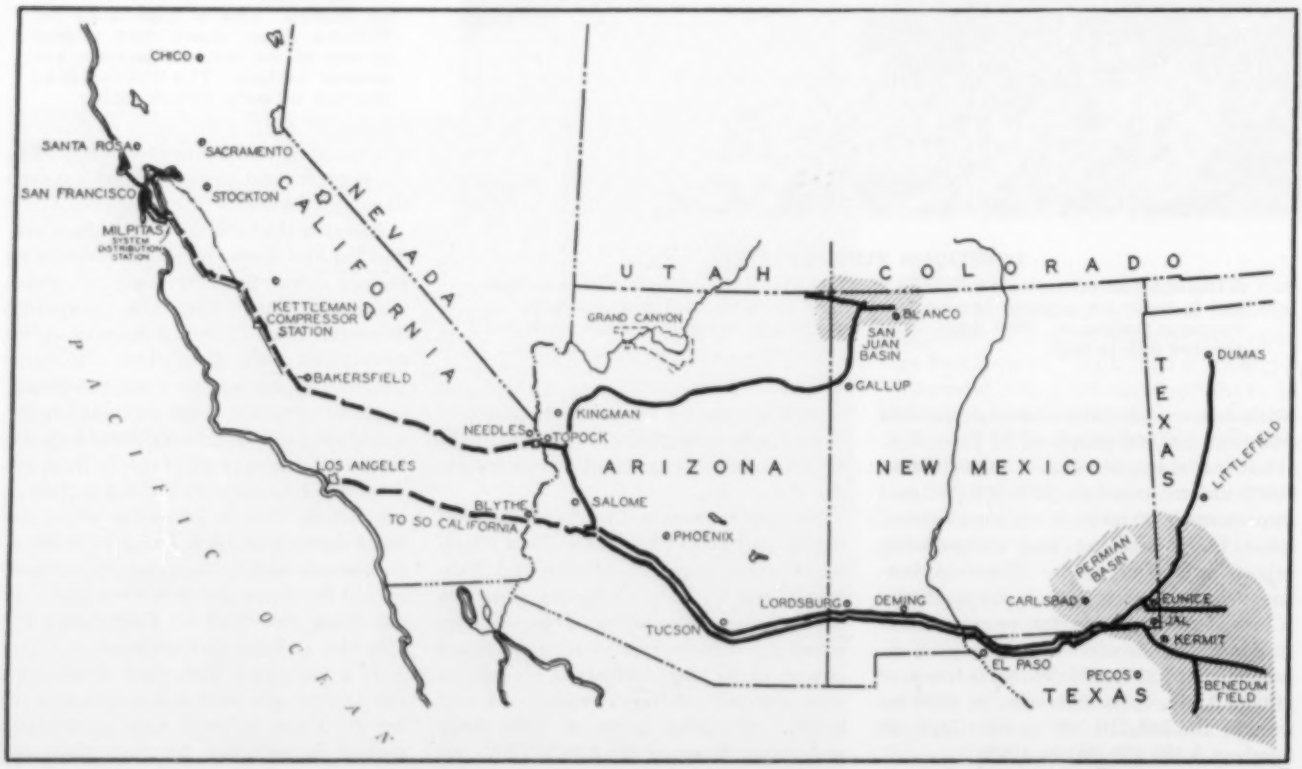
In 1950 almost 74 percent of the natural gas delivered to markets through the company's pipe lines was residue gas, representing some 198,432,294,000 cubic feet and being equivalent in fuel value to 33,072,000 barrels of oil. Dry gas from the natural-gas wells in the oil fields of the Permian Basin is used only to supplement the treated residue gas when the demand for the latter exceeds the supply.

Also significant from the standpoint of economies effected through the utilization of residue gas is the revenue paid the oil companies for this waste by-product by the El Paso Natural Gas Company. In 1950 it amounted to $11,800,000—a sizable contribution towards the exploration for and the development of more of the nation's oil and gas reserves.

The gathered and treated gas must be put under an initial pressure to start it through the transmission lines to markets, and it must be given pressure "boosts" at points along the route. Compressor stations are maintained at approximately 100-mile intervals on the main lines of the system to keep the daily deliveries of about 1068 million cubic feet of gas moving. The pressure at the suction (intake) side of such a plant is approximately 550 psi, and powerful compressors driven by gas engines raise it to a maximum of 830 psi, with the average discharge pressure close to that point. It has been determined through engineering data, coupled with the results of economic studies pertaining to the transmission of gas under existing conditions, that these working pressures and the 100-mile interval between stations are the most advantageous.

Now, however, to increase the flow through the pipe lines so as to keep up with and ahead of growing demands, the company has petitioned the Federal Power Commission for permission to build a large number of additional compressor stations, of which several are scheduled for construction this year. Exceeding in size and scope any similar installation in the natural-gas industry, some of these plants will be supplied with 5000-hp General Electric gas turbines powering Ingersoll-Rand centrifugal compressors. The plans call for the building of two between adjoining main-line reciprocating-compressor stations, leaving an interval of 33 miles instead of the present 100 miles between plants. This would add approximately 125,000 hp to the existing capacity, which is 301,680 hp.

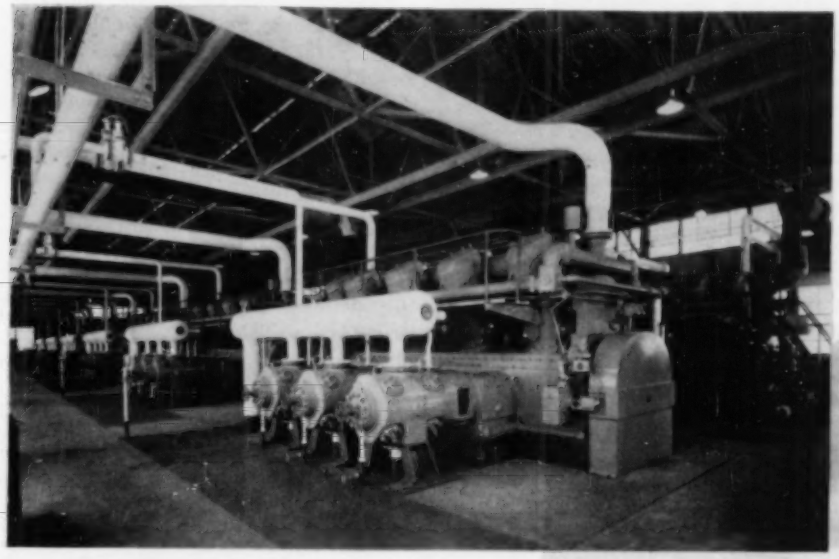
Needless to say, in an area where water is a scarce and precious commodity, mechanical equipment requiring minimum cooling with this medium wins favor. Water is needed, however, to cool the engine-compressors and engine-generators. Furthermore, the heat added to the gas by compression is reduced in cooling towers from a temperature of around 130°F to about 90° before the gas is readmitted to the transmission lines. To meet these requirements, it has been necessary to provide 60 water wells along the system. These range in depth from 30 to 1700 feet and are generally at the station sites, but one is as much as 6 miles away from the plant it serves. These wells vary in capacity from 18 to 350 gpm, further emphasizing the short-

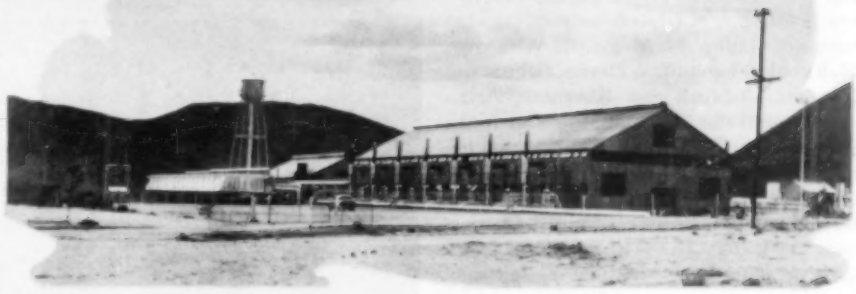


ADAPTED FROM THE "PETROLEUM ENGINEER"

MAP OF SYSTEM

Solid lines show the main gathering and transmission lines of the El Paso Natural Gas Company. Broken lines represent connecting links of California pipe-line companies. The section from Needles to the San Francisco area is operated by the Pacific Gas & Electric Company, and that from Blythe to Los Angeles by both the Southern California Gas Company and the Southern Counties Gas Company of California. Laterals and customers' connecting lines of the El Paso Company are not shown. The latter's first line ran from Jal, N. Mex., to El Paso, Tex.





GUADALUPE STATION

Located 95 miles from El Paso and 70 miles from Carlsbad, N. Mex., this is the most isolated of all the company's compressor stations and requires a complete camp site, including a school, for its workers. The large structure below houses fourteen Ingersoll-Rand Type XVG gas engine-driven compressors. Some of the units are shown in the interior view (left). Eleven additional machines of a similar type are in another building.

age and unpredictability of the underground sources. The company prides itself on the development of a satisfactory cooling tower using atmospheric air controlled by fans to cool the gas where the water supply is inadequate.

The Southern Line from the Permian Basin pushed westward slowly in the late 1930's and early 1940's, shooting out laterals and incorporating connecting lines from large customers to serve major industries and settlements as increasing supplies of gas were assured. A branch was added at an early date to the original main line—now consisting of a 30-inch, a 26-inch, and two 16-inch lines—to provide the needs of the potash industry of Eddy County in southeastern New Mexico, and another connection built by a customer was carried northward some 90 miles to deliver gas to the town of Roswell, N. Mex., and several farming sections en route. Near El Paso, a lateral reaches northward to the famous White Sands Rocket Proving Grounds and continues on to the community of Alamogordo and the Holloman Army Air Base, which is the headquarters for the joint-military guided-missile bombing range.

Westward from El Paso, which is now a city of approximately 130,000 persons with some heavy and many light industrial plants, a connecting line that is not a part of the company's system serves Las Cruces, N. Mex., in the fertile Mesilla Valley farming region. Still farther west, another lateral extends northward to fire the smelter and the electric power plant of Kennecott Copper Corporation's Chino Mines Division at Hurley, N. Mex., and branches out to satisfy the demands of domestic consumers in nearby towns. In southern New Mexico the line divides, entering Arizona at three points to better encompass the southern half of that state.

The plants of the principal copper mining companies in Morenci, Globe, Miami, Hayden, Douglas, Bisbee, Superior and Ajo in Arizona, and south of the border in Cananea, Mexico, have long been in the system. The major Arizona cities of Tucson and Phoenix are enjoying the conveniences of natural gas from the Permian Basin, and now a branch goes down to Yuma from a point near Ehrenberg, Ariz., across the Colorado River from Blythe, Calif. At Blythe, two Southern California distributing companies—the Southern California Gas Company and the Southern Counties Gas Company of California—accept the gas for the remainder of its 1200-mile journey from Texas to Los Angeles.

The new prong of the system—The Northern Line—has its beginning in the San Juan Basin of San Juan County, New Mexico, and in the adjoining Montezuma and La Plata counties of southwestern Colorado. There are both "sweet" and "sour" gas fields in the San Juan Basin. The former requires no treatment, but represents only a small percentage of the volume of gas gathered in the area, while some of the sour gas is the most highly acid gas known to the industry and has necessitated the building of the world's largest treating plant.

Increased consumption of industrial gas in the San Francisco and other northern California areas and depletion of much of California's available natural-gas reserves prompted the $44,500,000 San Juan Project, just as similar conditions several years ago in the Los Angeles industrial region caused it to turn for gas to the Permian Basin fields. That service was begun in 1947 via the Southern Line at the rate of 125 million cubic feet daily and gradually increased to 400 million cubic feet. By tapping the tremendous gas reserves of the San Juan Basin, and by linking the southern and northern main lines with a 30-inch-diameter pipe line in western Arizona, more complete and efficient utilization of the Permian Basin flare gas can be effected and a constant flow of fuel guaranteed consumers throughout the entire system. The connection extends from a point of the Southern Line near Quartzite to Topock, where the Northern Line crosses the Colorado River into California.

Dry gas from the San Juan Basin will be used to meet any deficiencies in the supply of residue gas that may occur at brief intervals in the Permian Basin. Since residue gas is produced in connection with oil that is under allowables fixed by state regulatory agencies, the flow may not always be sufficient to meet the varying needs of distributors and consumers. The San Juan Basin will therefore act as a booster and compensate for fluctuations that otherwise might cause serious service interruptions. It is estimated that an additional twenty billion cubic feet of residue gas,

the equivalent of some 3,300,000 barrels of oil, can be drawn from the Permian Basin each year in consequence. Of the total gas distribution in 1949, residue gas accounted for more than 83 percent, and in 1950 for nearly 74 percent. The company states that this high rate of consumption will continue, and that residue gas will at no time in the future be less than 75 percent of the total annual delivery.

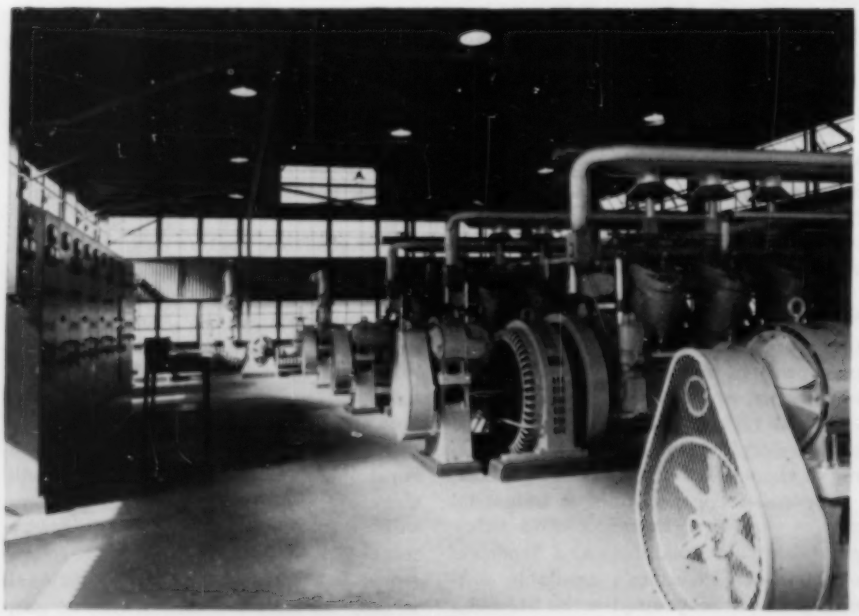
The 24-inch pipe line coursing for 450 miles from San Juan County, New Mexico, to Topock, Ariz., is expected to carry a peak load of 167 million cubic feet per day. According to present estimates, 150 million cubic feet will be transmitted to California and the balance will be available to users in New Mexico and in northern Arizona. In its westward march to Topock, where Pacific Gas & Electric Company will take over distribution to the San Francisco Bay area, the Northern Line has initiated service in the towns of Gallup, N. Mex., and Winslow, Holbrook, Flagstaff, Williams, Seligman, Prescott, Ashfork and Kingman, Ariz.

Although the 120-mile crossover from Quartzite to Topock was considered the most difficult section to install because of the isolation of the region, the rugged terrain, severe heat, choking dust and lack of water, the 450-mile Northern Line presented an even greater challenge to the pipe-line crews. With construction started in mid-1950, a race with time began. So that work would not come to a standstill and the line would be completed at the earliest possible date in 1951, it was necessary to finish by December the stretch east of Williams where winter conditions are severe and might halt operations. In the region west of Williams, which lies at a lower altitude, the pipe could be laid in the dead of winter.

The route of the Northern Line had to deviate from the straight line normally followed because much of the terrain was inaccessible and it involved traversing elevations ranging from 1100 feet at Topock to 7800 feet near Flagstaff. Too, National Monuments had to be avoided, and that added many miles. Starting in the high mesa lands of the San Juan and proceeding across the Painted Desert section of northern Arizona, the going was rough and continued so. Upon approaching the San Francisco Mountains of the Flagstaff-Williams area a thick ground cover of scrub cedar, oak and other foothill growth had to be arduously removed from the right-of-way. As altitude was gained in the region around Flagstaff that vegetation gave way to the towering pines of the Yavapai and Coconino National Forests and the "pipeliners" became full-fledged lumberjacks.

Emerging from the forests and descending slowly to the Colorado River Valley, other difficulties such as sharp foothills, hard rock, arid climate, dust and summer temperatures as high as 130°F had to be overcome. But fortune smiled on the workers in at least one respect: the winter of 1950-51 was unusually mild and the handicaps of blizzards, deep snows and severe cold were minimized. More than 160 miles of ditch had to be blasted in rock at an expenditure of around two million pounds of dynamite. Portable compressors and pneumatic drills played a major role in that work. Toiling under such arduous conditions and racing against time both men and machines were put to a severe test.

An obstacle was encountered in the Flagstaff section that stood out in sharp contrast to the 160 miles of rock work.



PROTECTIVE WRAPPING

Here a 24-inch line on the northern San Juan branch of the system is undergoing doping and wrapping. As the wrapping machine moves along, the Navajo at the end of the pole on the left keeps it from turning off the pipe. The corrosion-resisting coating, which is applied at a boiling temperature ahead of wrapping, is responsible for the cloud of steam.

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STATION GENERATORS

Interior of the electric generator station at the Fullerton, Tex., field plant that treats and dehydrates residue gas received from a nearby Phillips Petroleum Company natural-gasoline refinery. Four Ingersoll-Rand 370-hp gas engines, direct connected to generators, are shown. All the El Paso Company's plants develop the power they need, the facilities for this purpose totaling 28,110 kw of installed capacity.

ROUGH COUNTRY

It was tough going getting the line off the rim rock at the southern end of the Guadalupe Mountains in Texas. The 1200-foot drop on an average grade of 54 percent is the steepest on the southern branch of the system. A large double-drum hoist at the crest of the escarpment moved equipment up and down the incline. The pipe, in 60-foot sections, predoped and wrapped, was lowered into position by tractor-mounted hoists. To protect it from rough handling and the rocky ditch bottom it was wrapped in snow-drift fencing. The welders shown below are running five beads around the joint of two lengths of pipe.

Being an area of recent (geologically speaking) volcanic activity, much of the right-of-way was covered to a considerable depth with unconsolidated volcanic cinder and ash. The ditch-digging machines had easy going there, but behind them would be a trough only a few feet deep instead of the desired standard ditch. The loose material flowed back into the swath as soon as it was cut and necessitated shoring up the walls of the excavation with lumber—a painstaking procedure.

An unusual labor situation developed in preparing for the construction of a 218-mile stretch of main line and a compressor station that lie entirely within the Navajo Indian Reservation. In an agreement with the Navajo Tribal Council, it was stipulated that Navajos fill all the jobs for which they could qualify, and more than 250 were hired. Although most of them (about 80 percent) spoke no English and were unfamiliar with the work, the company was able through interpreters and with patience and capable instructors to train them rapidly and has recently classified them as a "smart, valuable, ambitious labor source." Many of the Navajos were promoted to skilled jobs as they qualified, and a number will be retained for permanent operating jobs.

Passed in 1908, the Federal "Law of Antiquities" stipulates that ruins and points of archaeological and historical interest on government land shall not be disturbed except by permission and under proper procedure in order to preserve them. Northwestern New Mexico and northeastern Arizona are rich in such treasures, known and potential, and a coöperative agreement had to be set up with officials of the National Park Service of the Department of the Interior so that the provisions of the law would be satisfied and pipe-line progress impeded as little as possible.

Jesse L. Nusbaum, senior archaeologist of the National Park Service, became consulting archaeologist to the El Paso Natural Gas Company, and five archaeologists were employed by the latter to work directly with the pipeline crews. Minor archaeological areas on the right-of-way were fully explored before construction was undertaken, but the line was rerouted around major sites such as large pueblo ruins that would have required weeks of excavation, mapping, etc. Some 300 sites of that character were found and were mainly of Pueblo Indian culture dating back to 700-1150 A.D. Museums were enriched with artifacts from the excavations, and a good deal of historical and archaeological data was accumulated.

Currently, the El Paso Natural Gas Company has 2800-3000 employees of whom about 1500 are on construction projects. The company not only builds practically all of its own pipe lines and structures but has an almost continual construction program underway. The incentive of new operating jobs thus created has enabled it to obtain and retain the best of experienced workers and has given rise to the boast that "our pipeliners may be the world's best—certainly none are better."

Maintenance is a major item in the operation of a pipe line, and this department calls for a large force of highly trained men. At the compression and treatment plants the work is much like that in well-nigh any industrial establishment, but the job of keeping a large cross-country line in top operating condition is, indeed, different. Emergency repairs may be difficult and often hazardous to make.

A pipe line has been described as a "twisting, writhing, temperamental, thin-skinned monster." It is affected by temperature changes, and because of the resultant expansion-contraction movements, engineering skill is required in laying the pipe and mechanical skill in constructing and maintaining it. Even slack loops and zigzag sections do not eliminate all dangerous stresses. This is

particularly true in hilly country where contraction when temperatures are low puts a terrific strain on pipe and joint at the crest of a hill. Where pipes are in contact with rough materials or objects, movement causes wear.

Stresses and abrasion are responsible for some of the dreaded leaks that must be quickly located and repaired, though floods have become the main cause of line breaks in recent years. Repairs must be made without interrupting service, and to weld a leak in a line carrying highly inflammable gas at 550-830 psi pressure is no chore for the inexperienced. Corrosion is another cause of leaks. All pipe laid is protected from corrosion, and considerable research has been carried out to determine the most suitable primers, wrappings and cathodic techniques for each of the soil conditions to which pipe lines are subjected.

The company attributes much of its operating flexibility, its ability to cope with emergencies and the initiative among its personnel to solve technical problems to its policy of building its own facilities. This reluctance to call in outside help, coupled with an urgent situation, was responsible for the development by members of its staff of the first economical method of treating large volumes of "sour" gas. According to available figures, it now processes more waste and acid gases than all the other organizations in the industry combined. Another "first" in "pipelining" is claimed by El Paso Natural: the initial 16-inch line from Jal to El Paso was the first natural-gas pipe line in the country of all-welded construction, and many improvements in technique made on that job contributed considerably to pipeline welding procedure generally.

Adhering rigidly to its "independence" policy, the company has provided a transportation system including just about every means of land conveyance and an adequate air arm. Elaborate telephone, radio, and telemetering facilities unite the entire network, and a 500-mile Philco microwave communications system now being installed on the Northern Line features the longest distance between stations yet attempted. The normal interval between relay stations is 20-40 miles, but several conveniently located mountain tops have made it possible to stretch the distance to approximately 50 miles in the case of this installation. The microwave equipment was developed in the Philco laboratories and can handle simultaneously 24 telephone conversations or several hundred teletype or telemeter channels.

The El Paso Natural Gas Company is looking sharply to the future. It estimates that its 1953 residue-gas deliveries will total 319 billion cubic feet, equaling in fuel value 53,170,000 barrels of oil and costing the company in payments to oil refineries some $19,150,000. If the applications for the $92,000,000 expansion program are granted by the Federal Power Commission, the company will be able to increase its daily deliveries from 1068 million to 1500 million cubic feet. The California distributors have indicated greater future demands upon the system: those tapping the Southern Line have expressed need for 150 million cubic feet a day to supplement their present contract for 405 million cubic feet, while the Pacific Gas & Electric Company on the Northern Line has asked that its present contract for 400 million cubic feet daily also be increased by 150 million cubic feet.

The value of the new pipe-line system to the economic welfare and growth of the vast area under consideration cannot be overestimated. It is a timely contribution made at no small cost in toil and capital and is proof not only of faith in the future development of our country but once again of the industrial resourcefulness of Americans. Compressed air has played a major role in all the construction work, and powerful compressors will keep the essential fuel moving to distant markets.

PHOTOS BY JOSEF MUENCH

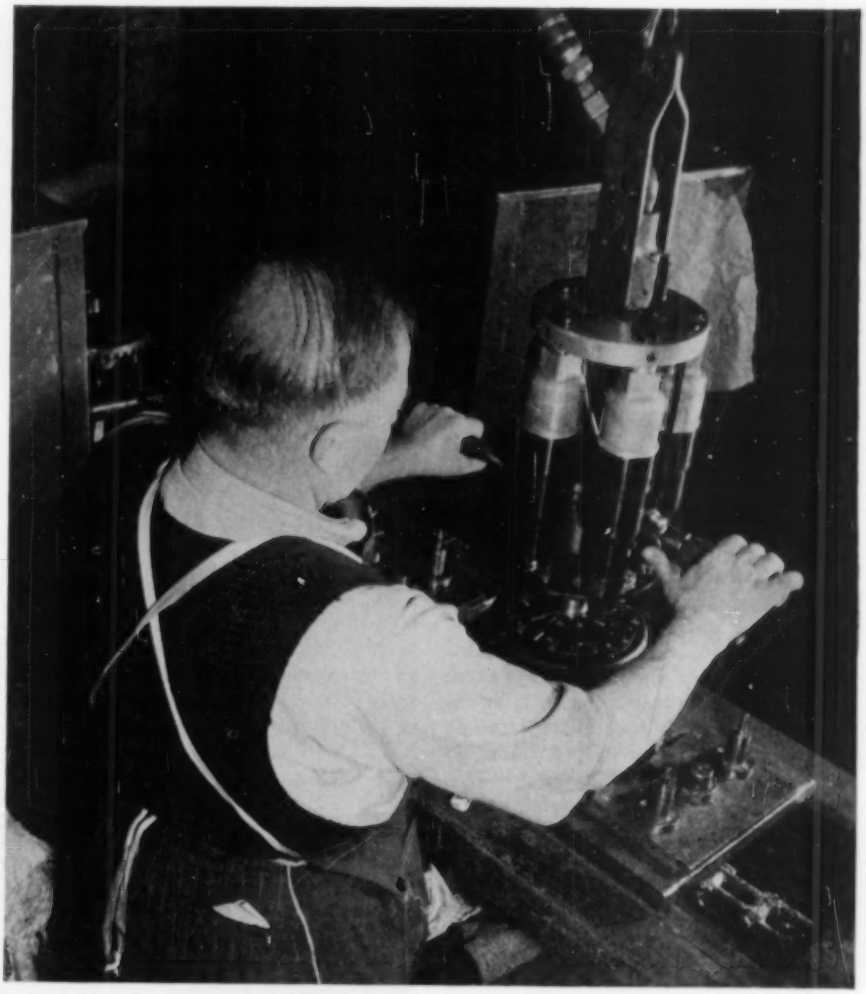
IN NAVAJO LAND

The Navajos, most populous of the Indian tribes (62,000) live on the largest (16,000,000 acres) reservation in the country. They normally raise sheep, weave rugs, and make silver-and-turquoise jewelry, but many of the men have worked on pipe-line construction projects. The one pictured with his horses now is a guide, but had a taste of "pipelining" back in 1943 and liked it so well that he adopted the name of Pipeline. Because he was receiving some government checks he had to have a full name so he consulted his white friend Jimmy Brewer, at the Tuzigoot National Monument, who suggested "Bing" (after Bing Crosby) and "N" (no name) as a middle initial. This sounded good to the Navajo, and he is now Bing N. Pipeline. The woman pictured is wearing some of the tribe's handicraft. Her child is laced into a hand-made cradle board in which infants spend months of their early lives.

Running Two to Eight Nuts at a Time

Multiple-Tool Machines Serve Automotive Assembly Lines

C. H. Vivian



RING-GEAR SUBASSEMBLY

The operator has tightened five of the ten cap screws around the circle and has his thumb on the button that admits air to a centrally located cylinder. As shown, this actuates a piston that pushes downward and raises the machine so that it can be turned to engage the remaining five screws without the necessity of lifting it. The tools are the 380M type that was designed by Ingersoll-Rand Company especially to permit making a compact assembly. The side-to-center distance is only 1⅜ inches and the length 10⅜ inches. Each tool weighs less than 7 pounds but delivers 1.65 hp when supplied with air at 90 psi pressure.

MASS production has reached its present amazing stage of development in the United States because of our success in designing and applying machinery to further man's efforts. As machines do more, the rate of production increases, the chance of human error is reduced and the product tends to become more uniform. One of the marvels of modern industry is the automatic machine. It takes many forms, and performs widely varying operations in the making of myriads of different things. Back of our ingenuity is, of course, our high standard of living. It is almost an industrial maxim that, given an output sufficiently large, machines to aid manual work will be quickly forthcoming.

The automobile assembly line was the incubator of mass production and probably still is the best example we have of it. Automatic machines contribute importantly to numerous preliminary operations but can seldom be brought to bear on the final assembly line. In fact, much of the mechanization in evidence there consists in the use of relatively small hand-held tools because the nature of the work demands guidance by human hands and brains. Consequently, assembly lines still require the efforts of many people and very likely always will.

Early in the development of the assembly line it was apparent that there was room enough alongside for only a certain number of workers. With hand tools, then, the rate of movement and, hence, the volume of production depended upon the speed at which these people could carry out their allotted tasks. An increase in output could be gained only at the expense of human exertion. Fortunately, however, there were already in existence a few pneumatic tools that could be adapted to perform some of the operations involved, and other tools were soon devised to meet additional needs. This trend has continued and, through the years, the automotive industry has been the cradle of much pneumatic-tool development.

Not only have some tools been designed for specific purposes, but all the tools used in that industry have been improved and refined to increase their efficiency and ease of operation. In view of these facts, it would seem that little more could be done to better the services rendered by them; but, actually, a recent advance has made it possible to reap some of the advantages inherent in the automatic mechanisms used in the production of parts.

The fruit of this new display of ingenuity is the multiple nut runner developed by Ingersoll-Rand Company. It came into being because it was noticed that, at a considerable number of places on automotive assembly lines, the same work was being carried out from two to five and more times, using one or more tools. It was realized that it would be of advantage if equipment could be provided that would perform these duplicate operations all at once.

From this observation and subsequent studies evolved the idea of combining in a cluster from two to eight tools, positioned and spaced to fit the requirements of the job in hand and capable of being run as one tool. Actually this had been done previously in at least one instance, but not in the automotive field. During World War II, an aircraft-engine manufacturer joined three Ingersoll-Rand Size 00 pneumatic drills to run down quarter-inch cap screws that held the cover on the rocker arm of its airplane engine. This unit was used with good results, but no further effort was then made to exploit it.

The first talks about applying the idea to the motor industry took place in Detroit two years ago. An Ingersoll-Rand representative at once made up some sketches for the first of the multiple-action tools. In due time the ma-

chine called for emerged from the shop and was put to work. It scored an immediate success, and this led to the development of others. Many of them are now used by automobile manufacturers and are performing a variety of tasks virtually all of which, however, involve the running of either nuts or cap screws.

The principal benefits realized by these multiple-spindle tools are what the trade calls "quality control" and a saving in time. Quality control in this case means that all the nuts, for instance, in a given operation can be tightened to the precise degree that will give best results. This uniformity is naturally highly desirable, and when there is surety that it can be achieved it is frequently possible to eliminate subsequent checking operations.

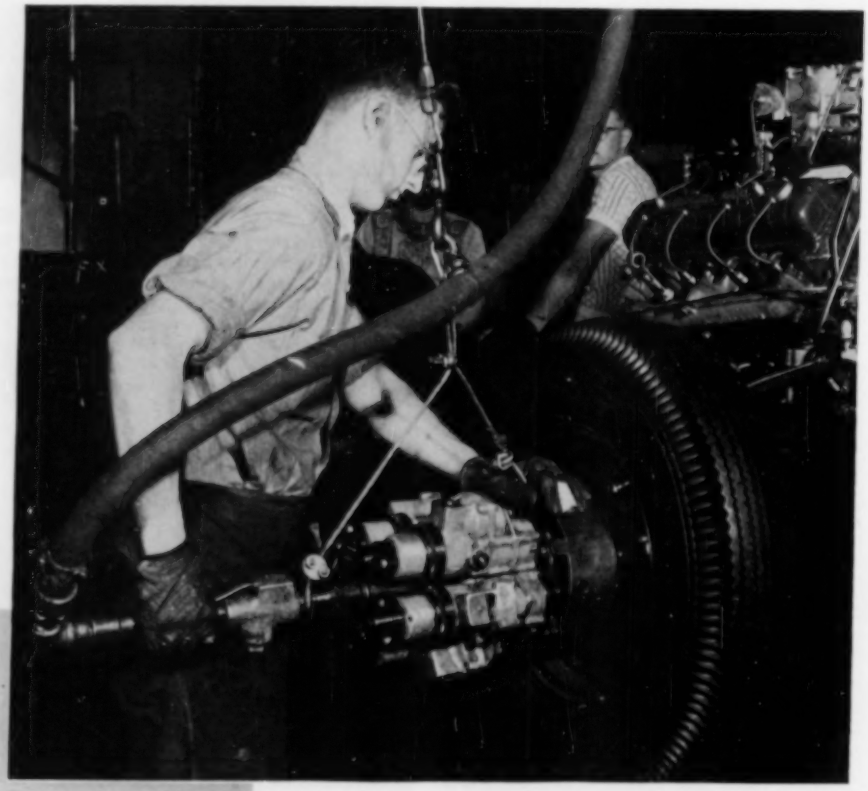
The reason uniform torque can be obtained at all the spindles is simple. It is common practice in work of this sort to run air tools until resistance stalls them. Since all the tools in a unitized machine are identical, and the air is fed to them through a common backhead, it is obvious that they will all stall at the same point of resistance and will, of course, do the same amount of tightening. This stalling, incidentally, does not hurt the tools.

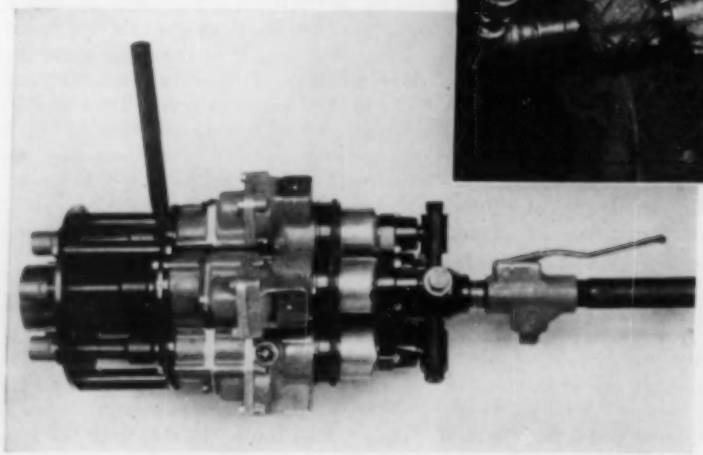
The desired torque can be obtained merely by controlling the pressure of the air. It is generally an easy matter to determine the optimum torque by experimenting with a single tool and varying the air pressure until the correct one is found. In making up a multiple-unit machine, a tool is selected that will develop the wanted torque at a pressure from 15 to 20 psi less than the available line pressure. This allows ample leeway for any subsequent increase in torque requirement or tool wear. A regulator is then interposed in the machine's air line to reduce the pressure, as needed. The pressures actually used range from 50 to 90 psi. As starting the several tools in unison imposes a sudden, heavy drain on the air supply, hose and fittings must be of ample size. In some cases it is also desirable to place an auxiliary receiver near locations where the machines are in operation.

Multiple-tool machines will often show tremendous savings in time. Sometimes this is important, sometimes not. For instance, under the procedure formerly followed, a worker may have been hard put to perform his assigned job fast enough to keep up with the movement of the assembly line. In that case a reduction in time is a distinct boon that makes for better labor relations. But if he had plenty of time his lot would not be eased appreciably. Moreover, a saving in time may mean nothing while a line is moving at its present pace, but it can possibly help to increase production later on if a change in line schedule is made. In other words, time saving is not now a factor, but it may be later on.

The initial machine was designed to simultaneously run five hexagonal nuts on lugs that hold an automobile wheel in place. This had previously been done by one man using an air-operated impact wrench on each of the nuts in turn. The new unit consists of five Ingersoll-Rand No. 2 Multi-Vane drills mounted radially in a holder and fitted with a common backhead and a single throttle. In this instance the nuts are given one turn by hand. The machine is then started and the sockets slid into place over the nuts. This requires little exertion by the operator, because the machine is suspended from a spring balancer. To facilitate making contact with the five nuts at one time, the sockets are spring-loaded to provide about $3/16$-inch end play.

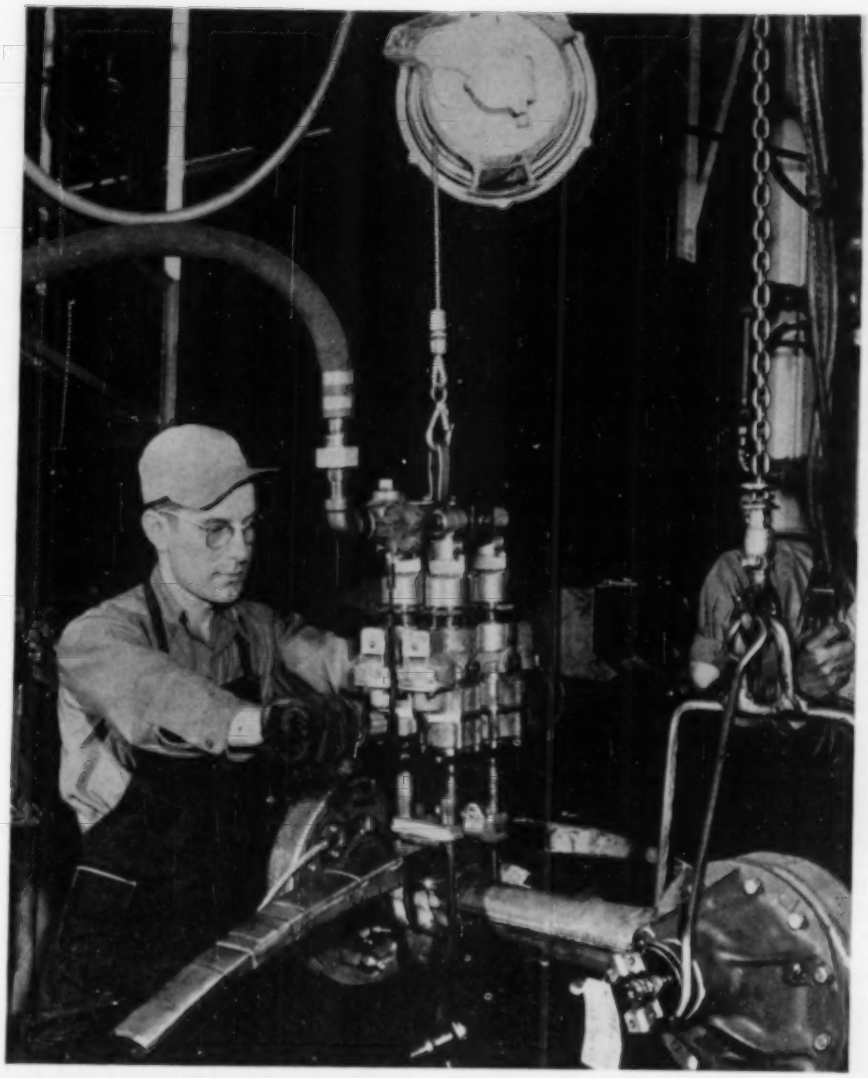
The next machine developed was for simultaneously tightening five cap screws on the differential ring-gear assembly of one of the popular makes of small cars. There are ten retaining cap screws in a circle, and they are tightened in two operations, alternate members being engaged each time. Because the circle of screws is too small to permit combining five standard tools within the available space, a special tool was designed with a smaller side-to-center distance. It is known as the 380M motor and has since been incorporated in other machines where extreme compactness is necessary. The slenderized effect was achieved by using planetary reduction gears.

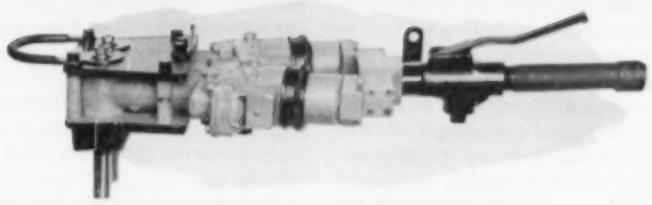




RUNNING NUTS ON WHEEL LUGS

With this 5-tool machine, which is used by several leading car manufacturers, a wheel can be secured in approximately seven seconds. Using air at a pressure of 75 psi, a torque of 100-110 foot-pounds is obtained. The tools are Ingersoll-Rand No. 2 drills. The assembly weighs 98 pounds and is the heaviest of the multiple-spindle units built thus far.





SPRING AND AXLE ASSEMBLY

Aside from the time saved in running four nuts on two U-bolts simultaneously (top picture), the multiple-tool machine does the job better because when each of the two opposing nuts is run down separately there is a tendency for one to loosen when the other is tightened. This picture illustrates clearly how these unitized pneumatic machines are suspended from overhead spring balancers that eliminate practically all human lifting. Below is a 2-tool combination that is used in one plant for U-bolt nut running. It consists of 28M angle wrenches. The average time required to tighten four nuts with it is 13-14 seconds.

To facilitate indexing or turning the machine after it has run down half the screws—to put it in position to engage the remaining five—a centrally located air cylinder was built into it. When the operator presses a conveniently located button, air is by-passed into the cylinder and a piston emerges from its lower end for about 1½ inches. This lifts the tool assembly, which is then balanced on this central point while it is rotated so as to spot the tool sockets over the five screws still to be tightened. Releasing the air pressure in the cylinder lowers the machine.

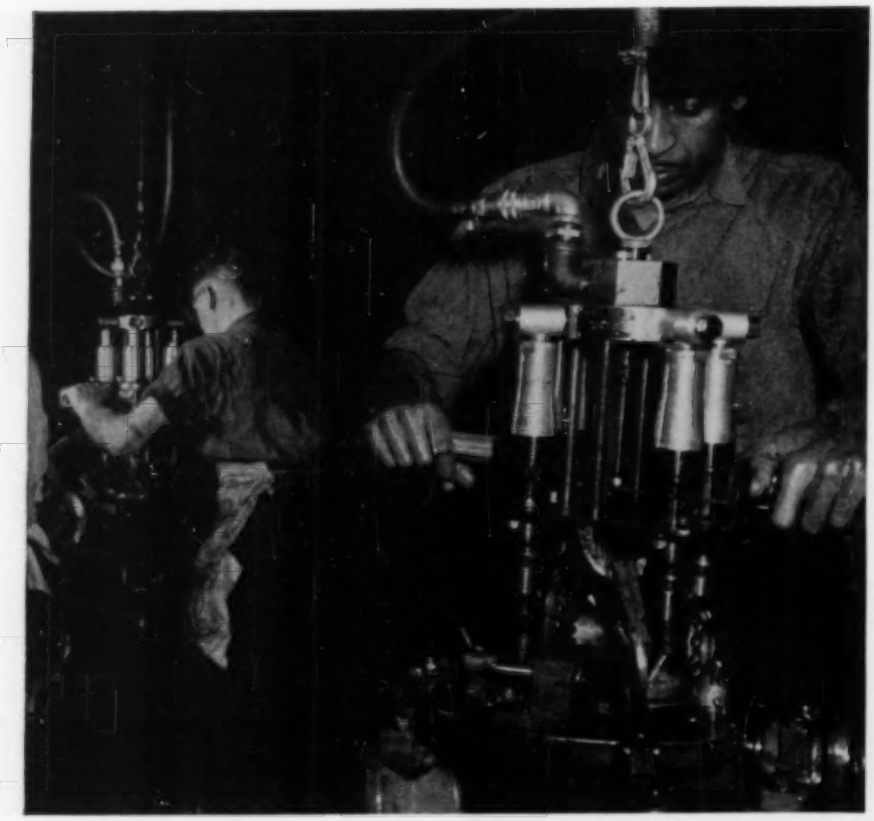
Before this multiple-action machine was introduced, three men performed the operation with individual nut runners. As the units passed by on the assembly line, the first man would tighten three screws, the next one three, and the last one four. From time to time this order would be changed so that the work came out about even. The line moves at a rate of 275 units an hour (more than 4½ per minute) and the operators were hard pressed to maintain the pace. In fact, a relief man came on for a time every hour to rest each regular worker in turn. Now two operators, each with one of the 5-spindle machines, handle the job with ease. Moreover, the cap screws are run down with such uniform tightness that it has been possible to eliminate checking with a torque wrench.

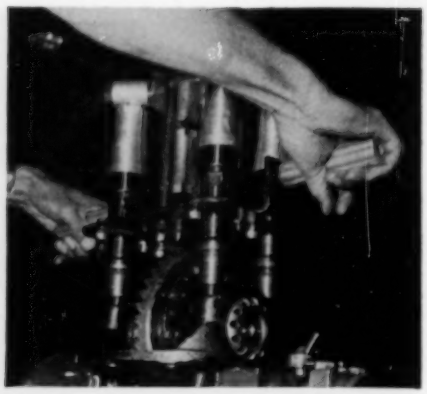
A machine that does the same job on another make of automobile incorporates eight tools—the greatest number so far combined. In this instance eight instead of ten cap screws are used and are arranged in a circle large enough to permit grouping eight tools in a ring to match the spacing of the screws.

Machines for running nuts on U-bolts that hold the rear spring and axle assembly together have been furnished several car manufacturers. In the typical case there are two bolts each with two nuts to be affixed, thus requiring a 4-tool unit. Size 2P motors have been utilized for the most part, and the advantages gained include both time saving and better quality control. The nuts are ordinarily applied while the threaded ends of the bolts extend upward. However, when installed on a car, the assembly is turned over. Consequently, if it is necessary later to adjust the torque of the nuts, this must be done in a pit by a man working overhead. Obviously, it is a

SHACKLE-BOLT NUT

This combination of two 2EL wrenches saves a leading motor-car maker 20 percent in time and improves the quality of the work an estimated 80 percent, as compared with the former procedure of tightening each bolt.





DIFFERENTIAL BEARING-CAP ASSEMBLY

In this operation, bearing-cap retaining nuts are run to the desired tightness, the assembly is machined, then torn down, bearings are inserted and final assembly is made. In the foreground of the left-hand view, nuts are being run on with a machine made up of four 0NB drills. In the background, nuts are being run off with a unit consisting of four Size 508 impact wrenches. Close-ups of these respective operations are shown at the right.

slow, undesirable, and costly operation, but it has been fairly common in the past because it is a difficult matter when coping with one nut at a time to tighten the two nuts on a single U-bolt uniformly. Since the multiple-spindle machine runs down the nuts on opposing sides of the bolt at the same rate of speed, it naturally does the job better and eliminates the need of making subsequent adjustments in the pit. While most automobile concerns that have adopted the new technique use a 4-tool machine, one leading company has a 2-tool unit. It is made up of two 28M angle wrenches.

In another application two machines facilitate the placing of bearing caps on a car differential. The cap is first assembled with the desired degree of tightness, then machined, dismantled, the bearings are added, and finally it is reassembled. There are four retaining nuts, and they are run on with four 0NB drills, which do the job in approximately half the time previously required. In the dismantling process, the nuts are removed with four No. 508 impact wrenches acting in unison. The time it takes to do this is roughly one-fourth of the former period.

Still another machine consists of two 28L wrenches mounted together to fit the rear shackle bolts on a popular car. As compared with the previous one-at-a-time performance, there is a time saving of 20 percent and an increase in quality estimated at 80 percent.

Not all the machines built so far are serving the auto industry. One, for example, is being used by a large manufacturer of electrical equipment to run down two nuts that secure a transformer cover. Two of the specially developed slender 380M motors are employed for this purpose.

Actually, these multiple nut-running machines can be utilized to advantage in assembling machinery of almost any kind. In general, they will justify their cost wherever from two to five or more nuts or cap screws have to be run and where the spacing between them is uniform. Potentially favorable fields include factories that produce tractors and all types of farm machinery. In the current defense-mobilization movement they can doubtless be profitably applied to the building of tanks. They promise to be especially helpful in the coming days when labor is probably going to be scarcer because workers can do a satisfactory job with them without previous training. This also goes for women, who may soon again make up a substantial proportion of our industrial army.

Even though several tools are running at one time there is no torque reaction on the operator. Apparently each tool absorbs the reaction of the others, and the entire group is as easy to hold as a single impact wrench. The heaviest machine thus far assembled weighs 98 pounds, but the weight imposes no problem when the set of tools is suspended from a spring balancer that does the lifting.

Experience to date has shown that maintenance of the multiple-tool machines is probably less than where individual tools are in operation, probably because they get better treatment. It is not unusual for a machine to be in service eight months without requiring attention. All the tools are of the vane type, and in time vanes wear so that they have to be replaced. The tools are assembled into a unit in such a manner that it is easy to remove one or more of them if occasion demands. In the event one tool has to be replaced for some reason and a new one is then running with several older ones that have been subjected to wear, it is still possible to make sure that all will continue to exert the same torque. This is effected by varying the speed of the several tools by means of individual regulators built into the common backhead.

Twenty Miles of Air Lines

Air Power Is Indispensable Aid in North American Aviation Company Plants

Data and pictures from Compressed Air and Gas Institute

TOOL APPLICATIONS

Although conventional riveting hammers are used to form most metallic connections, squeeze riveters such as the one at work above can be employed in some favorable locations. Using air at 90 psi it will exert a force of 5200 pounds. The other picture shows a pneumatic saw cutting a piece of aluminum.

THAT compressed air is essential to the building of a 70-group Air Force becomes apparent when one inspects the facilities of North American Aviation, Inc., which began the year with a backlog of orders for more than 1000 military airplanes that exceeded $400,000,000 in cost. The principal types in production are the B-45 four-jet bomber, which has a wing span of 89½ feet, a length of 74 feet, and can carry more than 10 tons of bombs, and the F-86 fighter with the sweptback wings that is capable of flying more than 650 miles an hour.

The uses of air in the company's plants range from the operation of thousands of pneumatic tools to the supersonic testing of airplane models. Especially noteworthy is the ease with which this adaptable power medium has been put to work on new orders because of the adoption of a standard pattern for the supply system. This applies to both the main factory at the Los Angeles municipal airport and the subsidiaries.

Distribution of compressed air is considered as important as distribution of electricity. The lines of both of these utilities are generally spaced 12 feet apart, with outlets every 8 feet. This arrangement may be changed slightly according to variations in the spacing of building columns. Though the initial cost of following such a standard pattern is greater, it increases operating flexibility, especially in the case of assembly work. J. P. McNamara, North American plant engineer, credits it with appreciable long-range savings. Working areas can be adapted quickly to the needs of small orders or to changes on models in large-scale production.

There are more than 20 miles of air lines, including 2 miles of primary distribution piping, in the main plant. Pressure drop is held to a minimum by the use of correctly sized pipe and a loop system that gives 2-way delivery to points where the demand for air is greatest.

Pneumatic tools are favored because of their light weight in relation to their power output and their durability. These important factors tend to increase production and to reduce maintenance costs. The tools not only differ in type but there are numerous sizes and varities of each type. Air-operated saws cut aluminum quickly and accurately, and midget air drills have many applications. Riveting hammers are, of course, used extensively, as are yoke and compression riveters. Other pneumatic portable tools include grinders, buffers, nut runners, screw drivers, chipping hammers, and wrenches.

Among the uses of air power for purposes other than driving tools, one of the most interesting is that of simulating conditions of supersonic flight. Miniature planes no larger than a child's toy are placed in a small tunnel. Air at a pressure of from 115 to 150 psi is first dried, and then its velocity is increased to supersonic range by passing it through a venturi throat leading into the tunnel. Even though this is continued for only a very short time, the volume of air required is so large that the tests are usually made at noon or some time when the other demands for compressed air are not at their peak. This is but one of several tests conducted by means of compressed air.

The machines employed for stretching sheet aluminum have pneumatic jaws. Air hoists are located in places such as paint-spray rooms where spark-free operation is necessary for safety. A quick-quench furnace uses air power to open its door and then to drop a ram that immerses heated metals in water. Air valves control the air conditioning system in the department where the expensive miniature test airplanes are made of wood, and air pressurizes the water for the spray quench in the heat-treating section. In the case of the latter, centrifugal pumps served at first, but the costlier application of compressed air was considered more eco-

PNEUMATIC TUG OF WAR

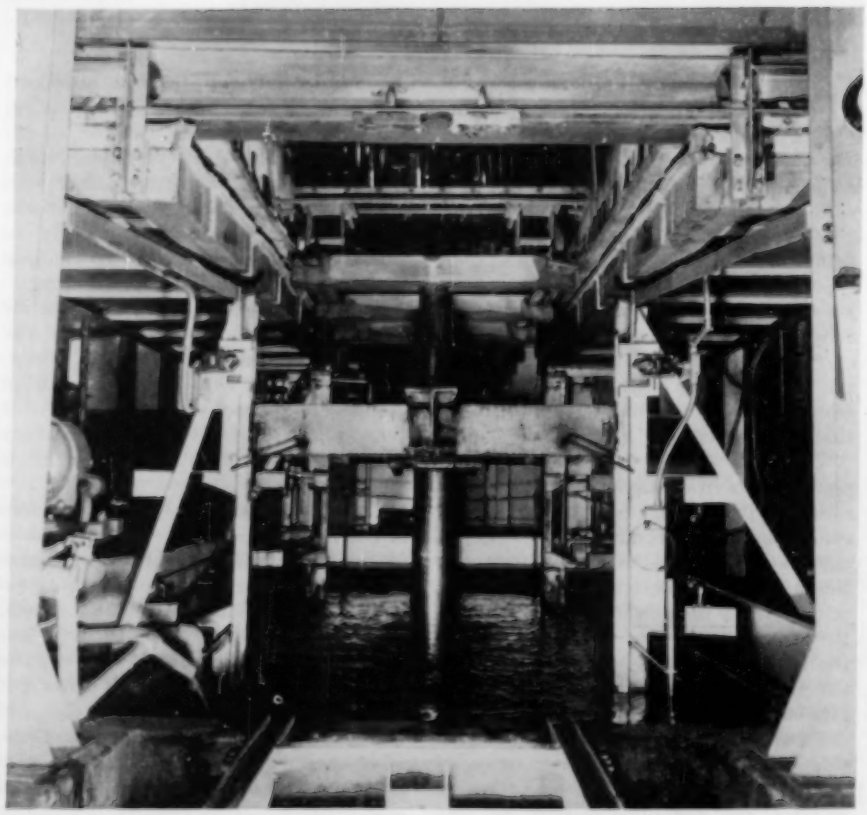
These air-powered jaws take tighter than a bulldog grip on the ends of the aluminum sheet, holding it while the camel-back under it is raised to stretch it, as desired.

nomical in the long run because it eliminated the dirt that was pumped in with the water by the former method.

The central air compressing plant consists of two 2-stage compressors each of 1500-cfm and of two units of 650-cfm each. Another machine of 1600-cfm capacity that was added later is located separately. It is used primarily for the supersonic testing tunnel.

Because compressed air is one of the main sources of plant power, the engineers are continually on the alert to maintain the system at peak efficiency. Most of the pneumatic tools, for example, deliver full output when operated with air at 90-psi pressure. Pressure drop at the tool means less work done, which explains why the company insists on a well-engineered air-supply system. Also, selection of the right tool for a given job improves production. Since manufacturers provide a wide variety of tools to meet all working conditions, the company takes pains to choose those that best answer the different needs.

These routine plant procedures help put in the sky more and better fighter planes that are breaking speed records and adding to our military might.



QUICK-QUENCH FURNACE

The doors on this electrically heated furnace are air operated, as is the vertical plunger in the center. By means of the latter, heated parts may be quickly lowered into the water bath.

Leadville Drainage Tunnel

Bore on Which Work Was Resumed in 1950 Will Unwater Millions of Tons of Vital Ores

MILLIONS of tons of lead, zinc and manganese ores are being liberated from a watery grave high in the Colorado Rockies. Flooded mines with blocked-out ore reserves are being drained by a 10,100-foot tunnel fast nearing completion. The Leadville Drainage Tunnel, near historic Leadville, has tapped some of the main watercourses in the district's principal mining section. The water level in the area affected is receding, and volumes up to 3765 gpm have been measured at the tunnel portal.

Water plagues mine operators the world over. There is usually too little or too much. In either case, it can be the factor that "kills the mine." The "too-much" water in the Leadville workings is attributed to melting snows from higher altitudes. Engineers of the U.S. Bureau of Mines have estimated that the total amount of water from that source finding its way into the Leadville mines through faults, fissures and other subsurface means averages 6000 gpm.

The battle against water in the Leadville District is as old as the flooded mines themselves. When underground operations started in 1874 with the discovery of silver-lead ores, water was the miners' worst enemy. In 1878 Leadville was referred to as "the greatest silver camp in the world." The Denver & Rio Grande Railroad reached the town in that year. Some 35,000 people in the district were living high on the basis of $15,000,000 in gold, silver and lead produced from about 30 mines and treated by ten smelters. It was a boom year for the community, but even then water was a threat against the continued prosperity of the camp.

Pumps were installed in individual mines that could afford them. Deeper workings were draining the more shallow

MEASURING FLOW

M. F. Buckbee of the U. S. Bureau of Mines is shown recording the flow of water through a weir a short distance from the tunnel portal.

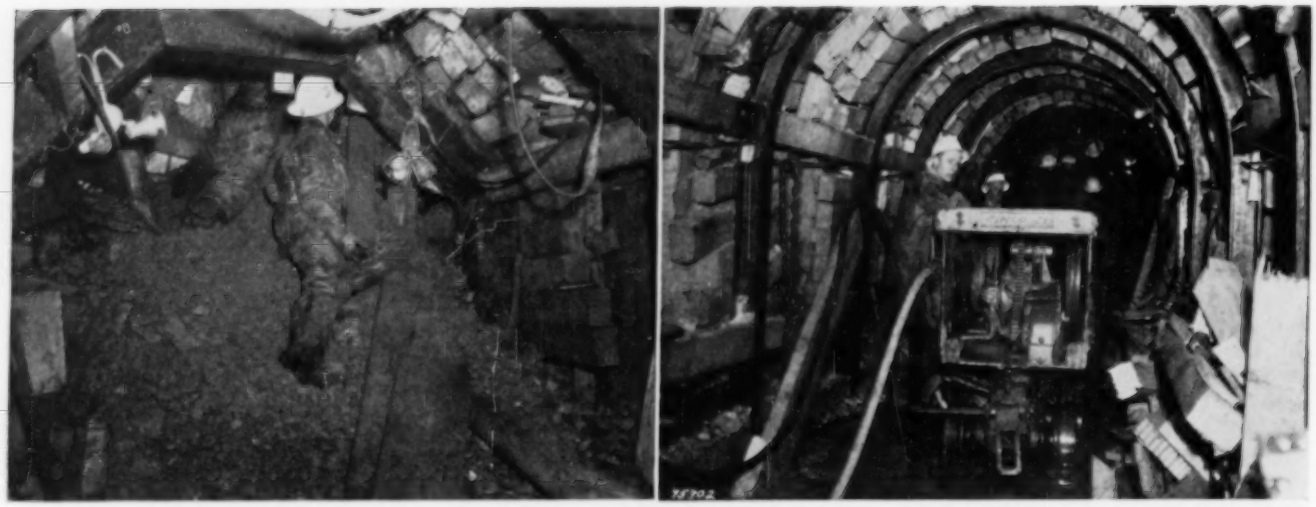
PORTAL OF TUNNEL

When this picture was taken, the ditch was carrying about 3600 gpm of water, enough to supply the normal requirements of a city with a population of 25,000.

neighbors, and disputes arose. Then, as the mines extended laterally and in depth and water increased in volume, common interest and necessity brought about joint pumping enterprises. Co-operative attack kept the water out, but it didn't keep the price of metals high and the employee-employer relations harmonious. Slumps in the price of metals and labor disputes caused the closure and the consequent flooding of the mines. Prior to 1933 those properties now being reclaimed by the Leadville Drainage Tunnel were pumped out seven times.

A goal set in 1932 is being partially attained with the completion of the tunnel. The Public Works Administration failed to approve the proposal in 1933, 1935 and again in 1938. Early in World War II the War Production Board had the Bureau of Mines review the case and investigate it thoroughly. Bureau engineers verified the feasibility of the tunnel and pronounced it an economical means of unwatering the mines so that the existing ore could be extracted. Their estimates of the values recoverable from the drained mines are as follows: two million tons of sulphide ores averaging 15 percent zinc, 3 percent lead, 3 ounces silver, and 0.02 ounce gold; one million tons of oxidized ores averaging 14 percent zinc; and perhaps an additional million tons of ore carrying 16 percent of manganese. Probable extensions of these ore bodies and new ore horizons are not taken into account in these figures.

Funds were appropriated by Congress,



TREACHEROUS GROUND

Fighting their way foot by foot through badly fractured quartzite, left, the miners are shown placing special timbering to support the enormous overhead weight and curb the flow of fine material into the heading. The other picture shows the steel sets and timber lagging necessary to hold out loose rock.

and the tunnel was started in December, 1943. The portal was cut near the banks of the East Fork of the Arkansas River at Elevation 9957 (a slightly revised location) and below most of the extensive workings of the old mines of the four principal ore-bearing subdivisions of the large Leadville District. Mines of the Fryer Hill, Carbonate Hill, Iron Hill and Downtown Section produced most of the $486,000,000 and more in metals credited to the camp since the discovery of gold in nearby California Gulch in 1860, and they embrace the recoverable ore reserves tabulated in the preceding paragraph.

Underground conditions proved a great deal worse than had been expected, and by August, 1945, funds were exhausted and work was suspended, with the tunnel face in only 6600 feet—far short of the 17,300-foot goal that included a 3500-foot lateral to drain the Downtown Section basin and another 2400-foot arm to unwater the Iron Hill basin. The project once again had to be shelved and wait for Congress to appropriate the money necessary for its completion.

Additional capital was made available in mid-1950, although only enough to carry the tunnel to the Robert Emmet Shaft at the 10,100-foot mark. The Utah Construction Company of Salt Lake City was awarded the contract to continue operations under the direction of J. H. East, Jr., Region IV Director of the Bureau of Mines. Work was begun in September, 1950, with some 55 men employed. The cross section of the bore was reduced from 9x10½ feet to 7x9 feet to conserve funds and to speed advance.

As the heading approached the mine areas, mineralization became evident and the possibility of developing "new" ore instilled enthusiasm in the tunnel-driving crews. They did have that satisfaction when, at the 8573-foot mark, they encountered a 15-inch fissure vein of ore on a bedding contact between shale and quartzite. The ore assayed more than 50 percent lead and 90 to 200 ounces of silver to the ton. Limestone, which is a host rock for minerals and in which have been found the important ore bodies of the district, is known to be some 65 feet above the tunnel level, which is in shale at this point. The vein, which leads upward toward that favorable ore horizon, will undoubtedly be exploited in the very near future.

Work in the tunnel heading was suspended in early July when a major watercourse was opened and the flow held at about 3600 gpm, with water hip-deep at the face. While waiting for the flow to subside, crews drove a 190-foot lateral that connects the tunnel with Hayden Shaft. In August, when the water volume had decreased to 3200 gpm, the crews were ready to resume operations with the current objective—the Robert Emmet Shaft—only 400 feet away.

LEADVILLE SKYLINE

The snow-clad Sawatch Range, dominated by sprawling Mount Massive (Elevation 14,418) which is Colorado's second highest peak, forms an impressive backdrop for dumps and buildings of mines that have yielded minerals valued at $486,000,000. The Robert Emmet Shaft in the right foreground is the objective of the drainage tunnel.

More Power at Niagara

ANOTHER huge hydroelectric plant is in the making at Niagara Falls. Situated on the Canadian side of the stream, it will produce 600,000 hp and will be laid out to permit doubling its capacity. The project is being carried out by The Hydro-Electric Power Commission of Ontario and represents the largest single undertaking ever handled by that organization. The total cost will exceed $157,000,000, and the initial generation of power is set for 1954.

Construction was made possible last year by the signing of a 50-year treaty between Canada and the United States providing for the diversion of additional water from the Niagara for power production. Due allowance for the preservation of the scenic beauty of the falls was made by leaving enough water in the stream for that purpose.

Water will be taken from the river at a point 3 miles above the cataract and directed for 8 miles to the powerhouse located 5 miles downstream from the falls and adjacent to the existing 525,000-hp Queenston Station. For the first 3500 feet it will be carried in a cut-and-cover concrete structure, whence it will enter a 5-mile pressure tunnel from 200 to 300 feet below the surface and passing under the city of Niagara Falls, Canada. Emerging from the tunnel, it will flow in an open canal for 2½ miles to the forebay of the generating station.

Construction involves the removal of some thirteen million cubic yards of earth and rock, of which two million will come from the tunnel which will be excavated to a diameter of 51 feet, or only 5 feet less than the record-size diversion tunnels driven at Hoover Dam on the Colorado River in 1931. It will be lined with concrete to a finished diameter of 45 feet. At the building site it will be necessary to cut down a 300-foot cliff to provide room for the power plant at the base and for the penstocks that will lead down to it. This will entail the movement of around five million cubic yards of material.

Preliminary to construction, 42,000 feet of diamond drilling was done to test the underground formations, which consist of beds of dolomite, limestone, shale and sandstone. Included were 60 holes totaling 12,000 feet along the tunnel line to determine the most favorable rock for the bore. It was decided to drive it at the junction of the Grimsby sandstone and the overlying Irondequoit limestone, both of which seem to possess sufficient stability to stand without support. The strata dip or slope at the rate of about 28 feet to the mile in the direction of the tunnel line, and the latter will follow that grade.

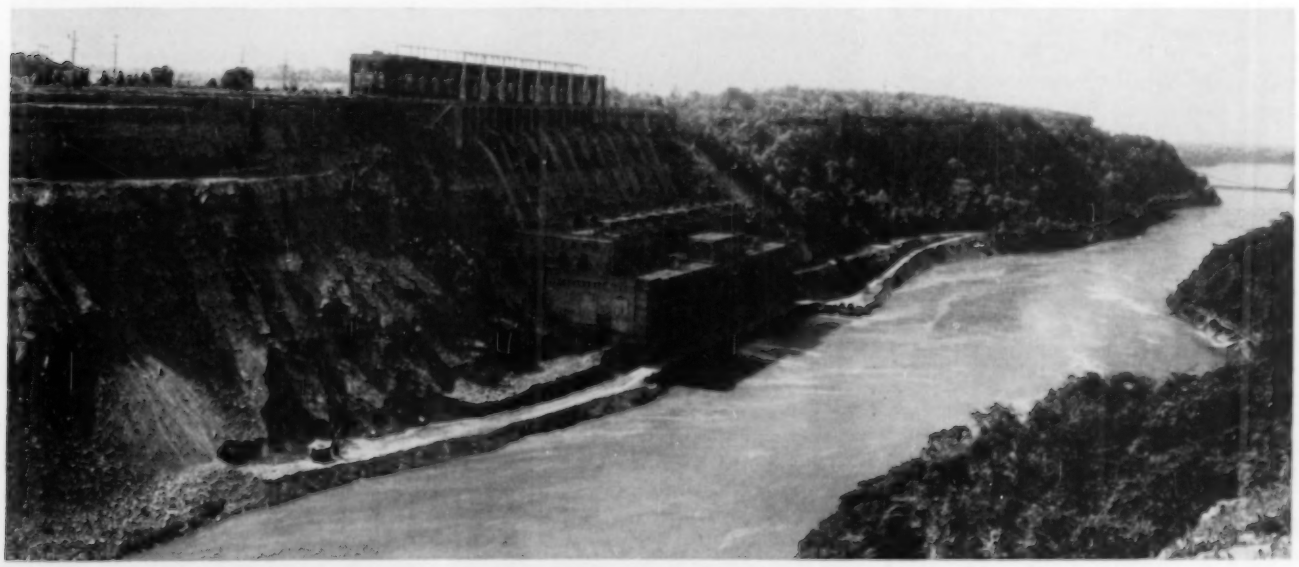
To facilitate operations, four shafts will be sunk at approximately equidistant points and headings will be opened in both directions from each, making eight points of attack in all. Contracts have been awarded to Rayner-Atlas Ltd. and to Perini, Pitts & Associates, each of which will sink two shafts and drive one-half of the tunnel section. Two of the shafts will be 32 feet in diameter and the other two 30 feet. The deepest will bottom at 330 feet and the shallowest at 210 feet.

The shafts will be located 125 feet to one side of the tunnel line, to which crosscuts will be driven. The purpose of the offset is to allow the same shafts to be used later in case it is decided to excavate a second tunnel. With that in mind, they will be lined and kept in good order. Meanwhile, the crosscuts will be sealed with concrete plugs. The large size of the shafts will permit lowering heavy and bulky tunneling equipment through them.

Details of the tunnel-driving method have not been worked out, but it is expected that a drill carriage mounting approximately 30 drifters at four working levels will be used at each heading. It has been calculated that about 240 feet of drill hole will be required for each foot of advance. Full-size power shovels will load blasted material into either diesel trucks or electric cars. Ventilation may pose a problem, because test borings indicate that there is some natural gas in the ground. To tap it off, one of the contractors is considering drilling a 12-inch hole every 400 feet.

The intake, open canal, forebay, and powerhouse will be built by the Hydro Commission's own forces. The canal will be 200 feet wide and approximately 60 feet deep and have a carrying capacity of 40,000 second-feet, or double the quantity of water needed for the present development, thus providing a reserve for possible expansion. From the top of the cliff, six penstocks, each 19 feet in diameter, will carry the water to six 100,000-hp turbogenerators in the power plant, which will be called Sir Adam Beck-Niagara Generating Station No. 2.

Work on the various phases of the project is underway and more that 2000 men were employed during the summer. This force will be gradually increased until a peak of around 5000 is reached in the fall.

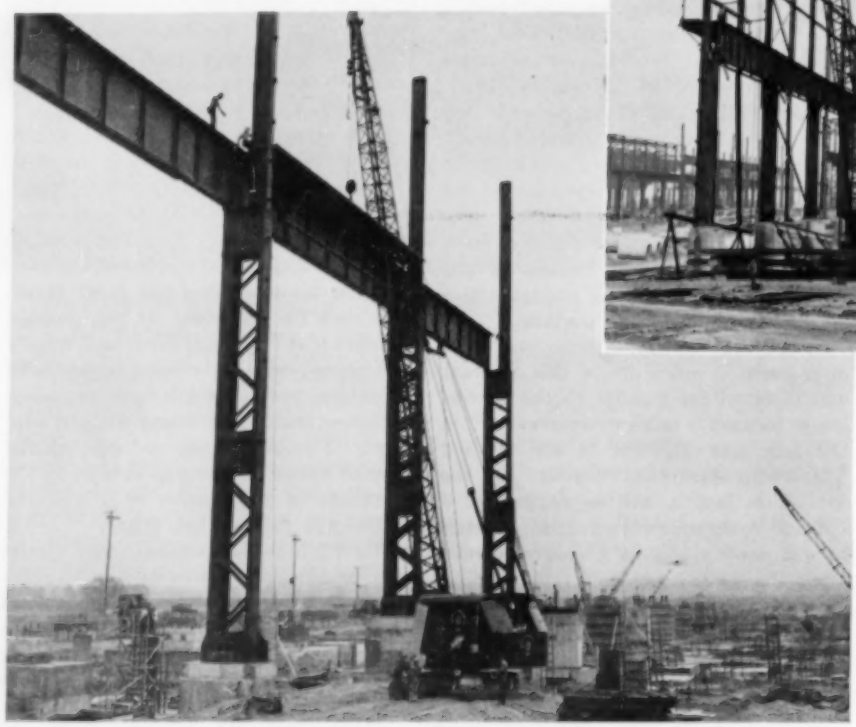


POWERHOUSE SITE

The Queenston plant and, left of it, the site of the new 600,000-hp station showing excavation in progress on the 300-foot cliff. Approximately five million cubic yards of earth and rock will be removed from this area.

Fairless Steel Works Rises

THE accompanying pictures, taken on August 2, show four months' progress in the erection of the United States Steel Company's $400,000,000 Fairless Works near Morrisville, Pa. Early last March the 3800-acre site in a bend of the Delaware River had only been partially cleared of farm homes and buildings and surrounded with 15 miles of wire mesh fence. A single railroad spur had been run in, no excavating had been done, and no building materials were on the ground. A few days later, however, the whole place was swarming with contractors' crews, dirt was flying, equipment was arriving by train and truck, and activity extended pretty much around the clock. As matters stand now, a batch annealing plant will go into service this fall for treating material shipped from Pittsburgh, other finishing departments will be ready for operation a little later, and the basic steel-making sections of the huge mill will begin functioning in the early part of 1952, as scheduled.



OPEN-HEARTH AREA

An American Bridge Company crane lifts into place the first steel members for the open-hearth building, other piers for which are seen in the background. The completed structure will house nine furnaces, each of 250 tons capacity.

When the plant was first visualized, the company's construction bureau consisted of a chief engineer, an assistant, and a few draftsmen. As planning progressed, it grew to include six officials, 65 engineers, 100 draftsmen and 35 clerks. These and several outside engineering firms tackled the big job of building the mill on paper. All told, 80,000 drawings were made, and the preliminary engineering efforts added up to around 9½ million man-hours, equivalent to the labors of one man for 4000 years. During construction, supervising engineering will come to an additional 2,000,000 man-hours or more.

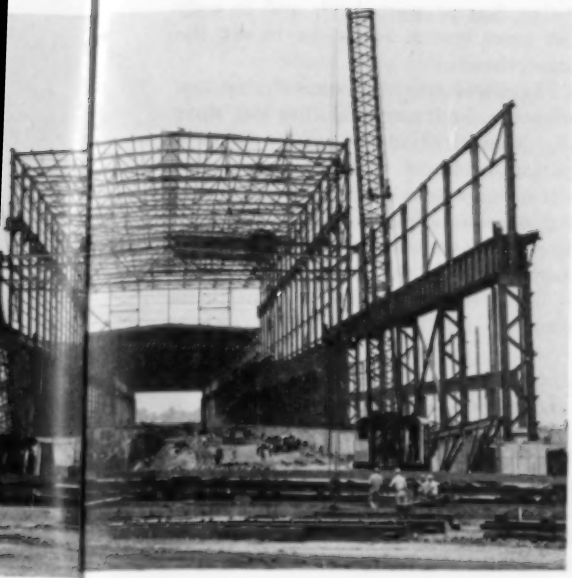
When the outbreak of fighting in Korea speeded up the construction schedule, things really began to hum. To obtain a topographical survey of the almost level tract as quickly as possible, aerial methods were adopted and, after checking, the result became the basis on which the quantity of fill required for building areas was calculated. Another preliminary step was the making of 200 borings to test the suitability of the subsurface for foundations. The explorations revealed a layer of sand and gravel, ranging from 10 to 20 feet in thickness, underneath a 5 to 10-foot mantle of topsoil and loam. Farther down are other strata of sand, gravel and clay, and at a depth of 75 to 150 feet is mica schist. The foundations of most of the buildings and structures will be carried down to the uppermost sand horizon, although in the case of some of the heavier ones piling will be driven.

When work began, the surface of the site was from 5 to 16 feet above sea level. As the plans call for the establishment of building grades at 20 to 25 feet and roads and yards at 20 feet, the filling in involved necessitates the handling of 7,000,000 cubic yards of earth. Included in this total is the excavation of a slip deep enough to permit docking ships that will bring in raw materials and take away finished products. By June 20 approximately 2,000,000 cubic yards had been moved, and the appearance of the tract had been so transformed that a former resident was 500 yards off in his guess as to where his house had stood.

Despite the widespread changes wrought, the builders have not wantonly destroyed anything in this history-rich section. With the help of archaeologists from the Pennsylvania Historical Society, the bodies in two old cemeteries were reinterred in new burial plots where the graves will receive perpetual care. Materials from several of the old structures on the site were carefully preserved and donated for use in the additional restoration of Mount Vernon, the Virginia home of George Washington. Some dwellings were moved intact to other locations, and some were dismantled and reconstructed elsewhere.

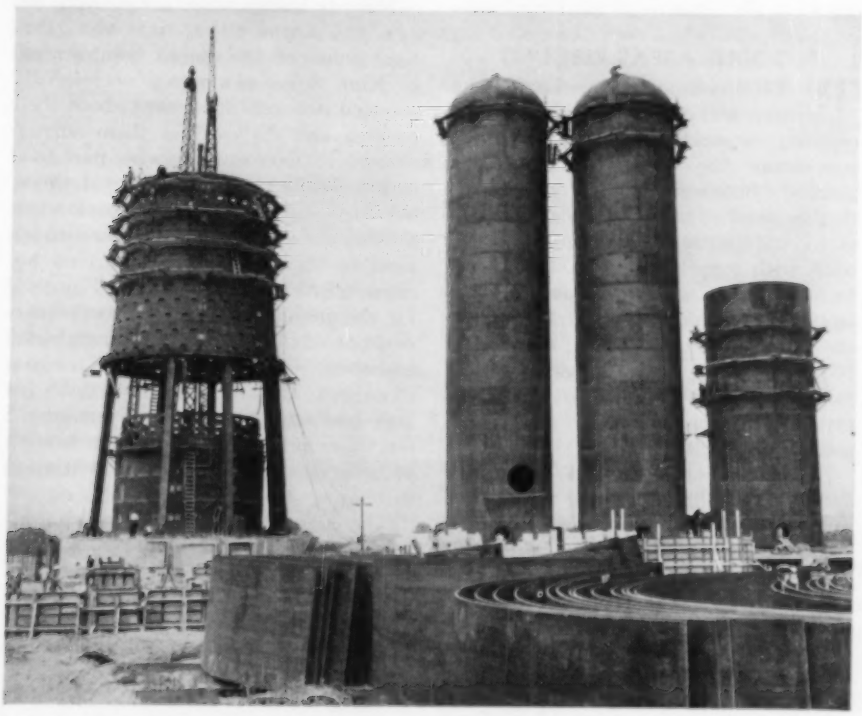
A few figures will give an idea of the size of the plant when it has been completed: There will be 175 acres under roof and 70 miles of railroad tracks within the grounds. For foundations and other structures, 500,000 cubic yards of concrete will be poured, enough to construct a highway 20 feet wide, 8 inches thick and 200 miles long. This concrete is now being placed at a rate of around 2000 cubic yards daily. In general, the mill buildings will consist of structural-steel skeletons and corrugated steel siding. They will be windowless, necessitating artificial lighting, and will be ventilated by means of openings at ground level and in the roofs.

Each of the two blast furnaces will be 105 feet high and have a 28-foot-diameter hearth. Foundations for it and associate structures will require 53,000 cubic yards of concrete, while its super-



CONTINUOUS ANNEALING BUILDING

As the picture shows, this structure is well along. It is scheduled to go into service in October and will, for the time being, treat material shipped from other U. S. Steel plants in the Pittsburgh area.



NO. 1 BLAST FURNACE

One of the two blast furnaces that are being provided and the three stoves that will heat the blast of combustion air to be delivered by a turboblower. Each furnace will be 105 feet high when completed.

structure will call for 4000 tons of steel and 3,000,000 refractory bricks for lining. There iron ore, limestone and coke will be brought together with air to produce the basic pig iron for the diversified steel products the plant will turn out. Each furnace will be tapped five times a day and yield around 300 tons of iron each time.

The pig iron will be converted to steel in nine open-hearth furnaces, each of which will require 2,000,000 bricks, enough to build 125 six-room houses. Some of these bricks will cost as much as $2 apiece. It is significant that the open-hearth process, by which 90 percent of our steel is produced today, was developed around 100 years ago largely through research carried on at the Trenton Iron Company, formerly located less than 6 miles from the Fairless Works.

Supplementing these basic facilities will be a primary mill for rolling steel ingots into slabs and blooms, a continuous-type 80-inch hot-strip mill, a full complement of sheet and tinplate finishing facilities including cold reduction mills, and billet, bar and skelp mills to furnish material for the pipe-making plant that will be operated by the National Tube Company, another U. S. Steel Corporation unit. Combined, they will turn out 1,800,000 ingot tons of steel annually and process it into numerous useful products.

In general, it takes 3 tons of raw materials to make a ton of steel, not to mention the huge volumes of air fed to the blast furnaces. A year's supply for the Fairless Works would fill a train of hopper cars 1250 miles long. For the time being, the iron ore, coal and limestone that make up the bulk of the constituents will arrive by railroad. Later on the ore, at least, will be delivered by boat, and equipment is being provided to unload it at a rate of 1500 tons an hour and then convey it by belt either to the blast furnaces or to storage areas.

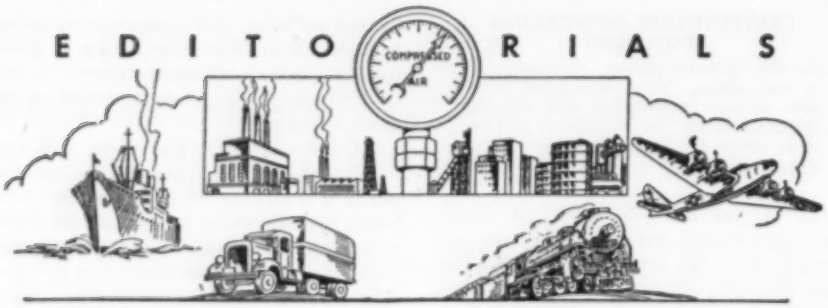
At full capacity, the plant will use enough electricity to supply the normal needs of a city of 450,000 persons. The main motors of the hot-strip mill alone will exceed the 34,000 shaft horsepower that drives the liner *America*, the nation's largest commercial vessel. Some of this power will be generated and the remainder purchased. The 9,000,000,000 cubic feet of natural gas the works will consume in a year would heat half the homes in Philadelphia. In addition, millions of gallons of fuel oil will be burned, as well as enormous volumes of gas produced in the plant.

It takes around 150 tons of water to manufacture a ton of steel products, and the Fairless Works will circulate approximately 230 million gallons daily. Up to 21,000 gpm will be required at the hot-strip mill to cool the rolls and steel, to descale the product and to operate the hydraulic machinery that will manipulate the slabs during rolling. Each blast furnace will use some 18,000,000 gallons for cooling purposes every 24 hours.

The water will come from three sources. The bigger portion, for cooling generally, will be pumped directly from the Delaware. About 8000 gpm will be drawn from shallow wells and will consist of water that has percolated from the river through subsurface sands. It will be employed mainly for cooling during the steel-finishing processes. Water for drinking and sanitary purposes will be obtained from deep wells. Fifty acres will be given over to a plant for treating process water before it is used and again after it has been used and before its discharge into the river. Because of the volume obtained from wells, more water will be returned to the stream than is taken from it.

Although steel mills are commonly supposed to contribute smoke and soot to the atmosphere, the people of the area have been assured that the Fairless Works will not do that. The blast furnaces will be equipped with dust catchers and electric precipitators. The fine iron dust thus retrieved will be melted, and the gas from which it is separated will serve as fuel. The open-hearth furnaces also will be provided with dust collectors. The coke ovens, of which there will be two batteries of 87 ovens each, will be designed to trap the gases in order that they may be processed to recover numerous chemicals that are the starting point for the manufacture of valuable products ranging from moth balls to nylon. The residue gas will be burned as fuel. Even the locomotives will not exhaust smoke because they will be of the diesel type.

EDITORIALS



STOCKPILING

TWO global conflicts within the past half century have proved that modern warfare is waged as much behind the scenes as on the fields of combat. Success at the battle line hinges largely on the effective functioning of production lines back home. In Napoleon's day an army traveled on its stomach; now it must have adequate supplies of many things other than food. Any nation faced with the necessity of defending itself successfully against an aggressor must stock not only its larder but its countless warehouses as well. In these storage depots must be big supplies of varied materials ranging from feathers to wool, from bauxite to tungsten.

For some months past, Uncle Sam has been diligently accumulating things we do not produce at all or in quantities too small to serve our needs if we should be drawn into a war. This stockpiling program is intended to do more than strengthen the sinews of war; the object is also to provide essential materials to meet civilian requirements under a wartime economy. All told, 73 items are on the shopping list, and to get them we have been combing the Seven Seas. We get rubber from Indonesia, talc from Sardinia, cobalt from Canada, tungsten from half a dozen nations and so on.

A report of the Munitions Board shows that up to June 30 we had received materials valued at three billion dollars and had contracted to obtain an additional 1.9 billion dollars worth. This total, however, is far short of our goal, which now stands at 8.3 billions. Before the objective is reached it may be extended. These diversified goods are being stored at 210 locations. The actual facilities may vary from a vault for the safekeeping of precious minerals and narcotics to an open, unguarded dump for ores of base metals.

The goods are ostensibly being stockpiled for withdrawal in the event of war, but the rule on this is not mandatory. If some of them seem to be needed right now in production channels, they are diverted to them in sufficient amounts to meet the current demand. Charles E. Wilson, head of the Office of Defense Mobilization, has the final say regarding them.

Suppose there is no war in the immediate future. What happens to the stockpiles then? Nothing, if those who are guiding our defense preparations have their way. They believe the knowledge that we have an adequate supply of everything we would need to wage war and to sustain overpopulation at home during a war would be a great influence for preserving the peace.

FLOODED AREAS REBOUND

TO THE volumes that have been written about America's productive capacity, something should be added concerning the nation's recuperative powers. Stricken by paralyzing floods that stopped all transportation and commerce, the Kansas-Missouri area snapped back with surprising speed. Although water as deep as 22 feet covered large sections of the industrial district of Kansas City, Mo., on July 13, more than 100 firms that manufacture products ranging from biscuits to heavy machinery were doing business "almost as usual" by August 4.

Some concerns resumed operations fifteen days after the flood hit; others required a longer time to get going. Actually, hordes of workers were tackling the herculean clean-up job only nine days after the peak of the inundation, and some production operations were put underway almost immediately. Within two weeks 23,000 industrial workers were back on their regular jobs.

Three weeks after the waters reached their peak, 90 percent of the scheduled passenger trains were running, an even hundred of the 137 truck lines serving the area were functioning, and all airline flights were operating. Wheat began moving into this breadbasket of America less than two weeks after the climax of the disaster, and 679 carloads reached Kansas City the first day. Two of the big packing houses resumed beef slaughtering within three weeks.

To let the world know that it was making a quick recovery and would be back to normal shortly, Kansas City organized a Flood Information Committee. Its headquarters handled all inquiries from the outside and was able to give information as to when different industries would be able to fill orders. Nine conventions scheduled for the city during August were held, and in only two cases was it necessary to set the dates ahead.

There was great human suffering and privation, and many families lost their all. Many individuals will be years in getting back on their feet and some will never regain what they have lost. But corporate business enterprises will be rid of their scars in an unbelievably short time. Here, again, is recorded a triumph for America's free-enterprise system.

EXEUNT HIGHGRADERS

ONE of the unexpected benefits of atom-splitting may be the eradication of highgrading, as the theft of ore from mines is termed. If this should transpire, science would chalk up a victory where mine owners have always met defeat.

Nobody knows when ore stealing began, but it was a long time ago. Perhaps some of the slaves who worked in King Solomon's mines occasionally secreted rich gold specimens about their persons and disposed of them surreptitiously. Ore was likewise purloined in the Saxon mines of medieval times, but highgrading reached its peak when the American western gold-mining camps were in their heyday. It thrived because illicit assayers provided outlets for the ill-gotten spoils that were carried out of the workings in lunch buckets, shoes, and even under the tongues of miners. Cripple Creek, Colo., at one time had as many as 35 assayers, about six times more than the camp needed in order to take care of its legitimate business.

The change system under which miners leave their working clothes on company property whenever they come off shift was instituted largely for the purpose of thwarting the efforts of the pilferers. An estimate that from 10 to 15 million dollars worth of gold is stolen annually from Canadian mines and mills was made recently, and it is from that country that the suggestion for ending the practice has come.

The scheme is a remarkably simple one that looks to be sure fire. Each mine or mill would add to its product a small amount of some inexpensive radioactive tracer material. The various producers would have their own distinctive isotopes, or would use a definite concentration. In either case, the dosage would constitute a "fingerprint" that would show where any lot of ore, concentrate or refined gold originated. Persons suspected of transporting or trafficking in "hot" gold could be "searched" with a Geiger counter. Governments, probably through their mints, could administer the plan, allotting radioactive "detectives" to only authorized gold shippers.

This and That

What's in a Name? Many persons can remember when machinery in this country was named for people. Railroad locomotives sometimes bore men's names on their sides, and stationary machines of various kinds, including air compressors, were occasionally similarly adorned. Company officials or other individuals who had played prominent parts in the organizations concerned were usually singled out for such honors.

In Syria today the custom is being reversed, according to a dispatch from Damascus in the *New York Times*. Farm machinery has only recently been introduced in the cultivation of cotton, and large growers have begun to use pumps along the Euphrates and its tributaries for irrigation. These are held in such awe by the natives that they christen their children for them. Thus, a boy may be named Mohammed Consolidated Pumps Incorporated.

★ ★ ★

British Tunneling Record A British record for advancing small-bore tunnels was established recently, according to *The Engineer*, of London. Through diorite of the Cobbler Range, crews drove a 7-foot-square heading 427 feet in seven days of round-the-clock work. The mark was set by forces of Edmund Nuttall, Sons & Company (London), Ltd., on a collecting aqueduct for the Loch Sloy hydroelectric system of the North of Scotland Hydro-Electric Board. This is said to be the first time more than 400 feet of rock tunnel was driven in a week in the British Isles. The previous top figure of 334 feet was made recently in the Bowland Forest Tunnel of the Manchester Corporation's waterworks scheme. The best progress in one month at Loch Sloy was 1231 feet.

★ ★ ★

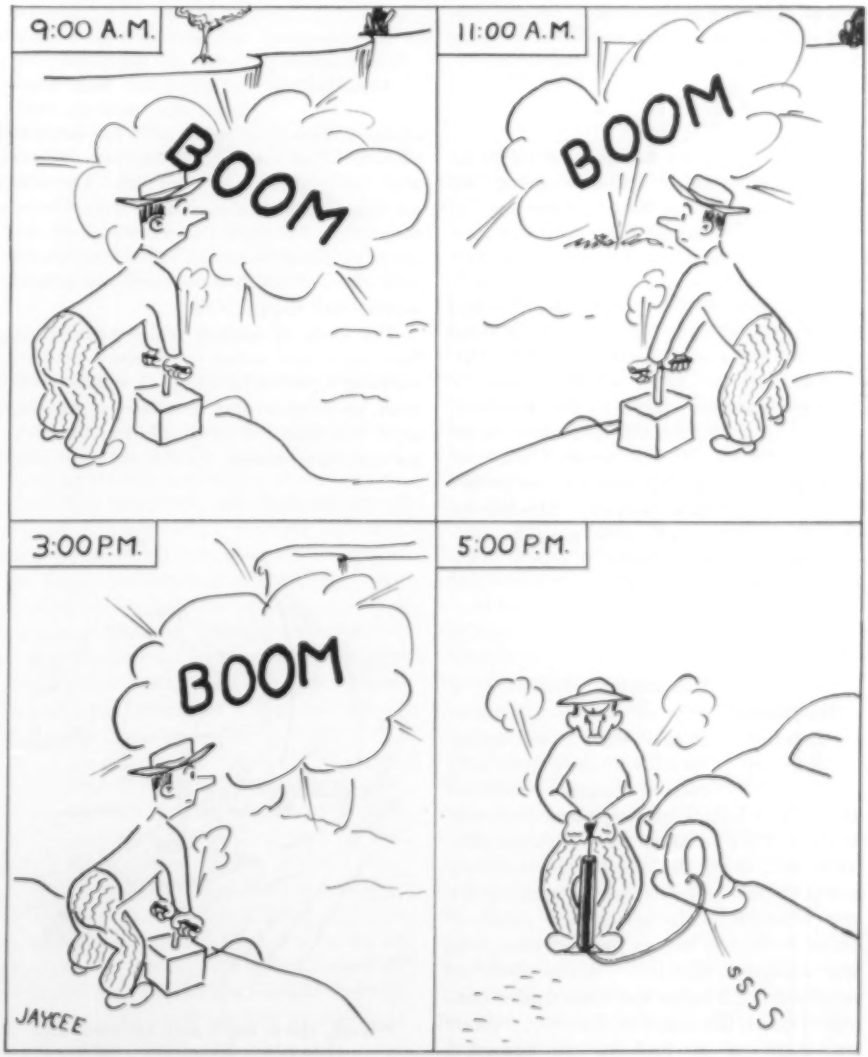
New Aid for Well Drillers The use of compressed air instead of mud circulated to remove rock cuttings while drilling holes for detonating explosives in oil-field geophysical prospecting was described in our January, 1951, issue. The same technique, it is stated in *World Oil* for August, has been successfully employed in drilling gas wells with standard rotary tools in the Blanco Field of northwestern New Mexico. However, because natural gas is plentiful there, it is substituted for air. The conventional method of circulating mud in the hole is unsatisfactory when completing a well because a great deal of it is lost in the porous formation. Gas not only overcomes this difficulty but has, in addition, increased drilling efficiency. The daily footage has been increased from a maximum of 200 to 700 or more, and a bit that averaged 80 feet of hole with mud is now good for from 300 to 400 feet.

★ ★ ★

Blasts Kill Fish Geophysical exploration for oil involving the use of explosives off the coast of California was forbidden in August, 1949, because a considerable number of fish was being destroyed. Experiments conducted since then by the Union Oil Company and the Scripps Institute of Oceanography have revealed that little damage is done to marine life when black powder is substituted for dynamite. As a result, the California Fish and Game Commission has agreed to permit the resumption of seismic prospecting this month. The kill rarely exceeded the total of fish taken in a day by a single commercial fishing vessel, according to the oil companies concerned, but operations were nevertheless restricted and it was ruled in 1948 that interested concerns must conduct their operations jointly. This was done with from three to eighteen participants until a day in August, 1949, when an exceptionally large number of fish was killed. It was then that the practice was banned.

★ ★ ★

Factory Drills for Gas Few factories have a source of fuel on their own property, but Sharon Steel Corporation may be in that category and intends to find out. Drilling was begun the last week in July on a farm adjoining the firm's Roemer Works at Farrell, Pa., with the hope of striking natural gas at a depth of around 3800 feet. Geologists believe that there are three possible gas-bearing formations under the property. Oil and gas was withdrawn from around 700 feet at one time, but the wells were



abandoned 30 years ago. Today, the nearest gas production is 15 miles away. At present the factory operates on natural gas that is piped in and fuel oil that is hauled in.

★ ★ ★

Less Cobalt Used

Cobalt, which has been in short supply, is now being used at a lower rate than at any time during the past fifteen months, according to the Defense Production Administration. First-quarter consumption this year was 2,322,820 pounds, a decline of around 17 percent from the fourth quarter of 1950 when consumption broke all records. Domestic output of cobalt, on the other hand, rose 8 percent in the initial quarter of this year, and imports were up 62 percent. The only current producer of cobalt in this country is Bethlehem Steel Company, which obtains it as a by-product in the iron ore it mines at Cornwall in eastern Pennsylvania. Cobalt has numerous industrial applications, but most of it is now going into alloys that are important in the defense program. The metal also enters into tungsten-carbide inserts for rock-drilling bits that are used in producing numerous strategic minerals.

★ ★ ★

Sweden Rich in Iron Ore

While American steel companies are now going as far as South America for some of their iron ore and contemplating the day when high-grade domestic deposits will be exhausted, Sweden finds herself comfortably fixed with rich ores for a long time to come. According to Dr. Per Geijer, retiring head of the nation's geological survey, those in the northern part of the country will last for at least two centuries at the present rate of mining, and large deposits also are available in the central section. He thinks additional low-grade ores may be discovered, but is doubtful if much more rich ore will be found.

★ ★ ★

Stockholm Extends Subway

Stockholm, Sweden, a city of nearly a million inhabitants, is extending its subway system to help relieve transport difficulties. The initial underground line was built in 1933 to serve the southern suburbs and, until 1950, operated ordinary street cars. Next came a section for the western outlying areas. Both of these links run above ground except in the business district. Since 1945 an additional 2.3 miles has been under construction in the heart of the city. About one-third of it had to be tunneled through solid rock, and this work, which involved the underpinning of many adjacent buildings, was completed by 1949. The Stockholm School of Economics had sunk one inch and was restored to its original level by jacking. The Concert Hall, resting on fine gravel and sand, was strengthened by injecting a mixture of water glass and calcium chloride into its supporting ground area.

When the west-south lines have been hooked up there will be nine underground stations, the largest of which is being designed to handle 60 million passengers a year. Most stations will have intermediate levels that will house shops. Walls will be of one-color tile and lighting will be with fluorescent tubes. Concrete pillars will be polished to bring out the luster and pattern of specially selected pebbles in the mix. Cars will have capacities of from 140 to 160 riders and eight will make up a normal train. Maximum speed will be approximately 44 miles per hour, and during rush periods trains will run 1½ minutes apart.

★ ★ ★

Inexpensive Underground Ventilation

A recent U.S. Bureau of Mines report tells how a portable air compressor was successfully used to ventilate a mile-long mine adit for several weeks. The Geological Survey, which was making a study of the Tenmile mining district in Summit County, Colo., wanted to examine the workings of the inactive King Solomon Mine but found that the air 700 feet in from the portal would not support life.

The cost of setting up a ventilating fan, pipe and other equipment and of making a power connection was considered prohibitive for temporary service, so it was decided to determine whether an air compressor would do the job. A 5-man crew and a burro were hired to haul 2-inch pipe into the adit and put it together. The installation was completed on August 31, 1950, and the engineers were supplied with air for three weeks. The expense, except that of moving the compressor and pipe to and from the site, amounted to $1,536.09. After detailing the methods utilized, the report concludes:

"Long adits and other underground workings having only one surface outlet can be ventilated with a relatively small volume of compressed air, provided the underground atmosphere consists of air deficient in oxygen only and does not contain concentrates of carbon dioxide or other gases difficult to dilute or remove; also provided the time element involved in ventilating the workings is not too essential."

"Well, there isn't any breeze, and this is working, isn't it?"

★ ★ ★

California Gold Mine Sues U. S.

The Idaho-Maryland Mines Corporation of California has brought suit against the U. S. Government for damages allegedly sustained from the enforced wartime shutdown of its gold-mining properties under the provisions of Limitation Order No. L-208. As a result of the inactivity from October, 1942, on, the expense of maintaining the mines, and the cost of restoring them to production, the concern claims that it has lost $5,021,799 and asks repayment of that sum, together with interest from July 1, 1945.

Prewar profits of Idaho-Maryland ranged as high as $1,124,000 in 1937, and the payroll numbered nearly 900 men in 1940. For the first half of this year the profit amounted to $6820. Outcome of the suit will be watched with interest by other American gold-mining companies that were obliged to suspend operations during the war and that have had a great deal of difficulty in resuming profitable work.

★ ★ ★

Abrasive Sprayed in Water

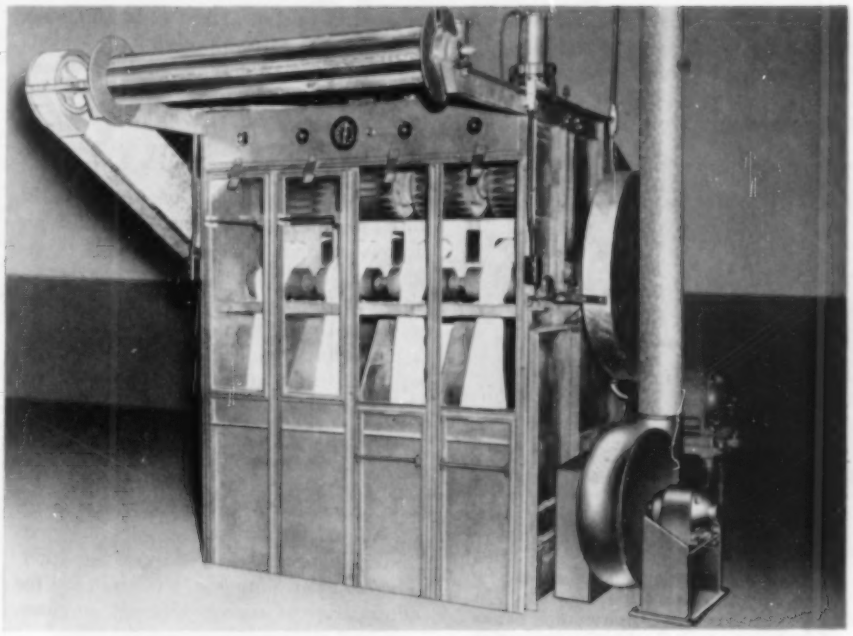
Fine abrasive dust suspended in water and sprayed by high-pressure air will produce high finishes on both metallic and nonmetallic products, according to Pangborn Corporation. Impact of the abrasive, some of which is as fine as talcum powder, removes minute amounts of material from the surface blasted. Actually, it is claimed, millions of microscopic pockets are formed, and on working surfaces these hold oil and improve the operation and life of the part. Machines embodying the new technique have been built to remove heat-treat scale from up to 700 automotive piston rings and pinion gears an hour.

Crusher Removes Carbon from Cloth

IN our February issue we had a short article on carbonizing woolen cloth by running it through an acid-soaking tank of an improved type, a drier and a baker to convert the contained vegetable matter into carbon. Since that time, Riggs & Lombard have announced another piece of finishing equipment that takes up where the baker leaves off and is said to do its work twice as fast and better than the old-style model. It's a semicontinuous crusher through which the carbonized fabric is run to remove the carbon, work known in the trade as "dusting."

The machine has four identical compartments, each with a pressure roll on top and a driving roll at the bottom. As the cloth comes from the baker, it is put into the compartments, one piece in each with the ends sewed together to form a continuous rope. Mounted on top of the crusher are four air cylinders which both lower and lift the upper rolls and force them down upon the material. Under the pressure of the top rolls, which are fluted to exert a crushing action, the carbon particles in the fabric are reduced to dust as it travels round and round at the rate of nearly 300 yards per minute. This high speed throws the cloth against the back of the machine with such force that it shakes out the dust, leaving the fabric exceptionally clean. The dust is continually removed by a built-in exhaust system with integral ducts and a motor-driven fan.

Each compartment can be loaded or unloaded without stopping the others simply by raising the top roll. With the pressure thus released, the material comes to a halt, permitting its removal and the substitution of another piece. The air-cylinders are under fingertip control and, by regulating the pressure, make it possible to run four different fabrics, each requiring a different crushing pressure, through the machine at the same time with equally satisfactory results.



"DUSTS" WOOLENS

The motor-driven semicontinuous crusher showing the four separate compartments loaded with cloth, the exhaust system (right), and one of the air cylinders that apply pressure to the fabric through the top rolls and also serve to lower and lift these rollers. Each cylinder can be operated and controlled separately from the front panel of the machine so that different kinds of cloth can be handled at one time and the pressure varied to meet their needs.

Nickel Company Forsakes Open Pits

IT IS not unusual for mining companies to convert from underground to open-pit operations and thus increase production. Surface mining with power shovels, truck and rail transportation, and its other inherent features is conducive to low-cost, high-tonnage extraction. The mining world may therefore be surprised to learn that a major company is going completely underground from a combination pit-underground operation and stepping up tonnage appreciably as a result.

The International Nickel Company of Canada, Limited, is doing just that, but it is being forced underground because its great Frood-Stobie open pit, producer of millions of tons of nickel ore, is approaching exhaustion. Inco is planning to hoist its entire output of 13,000,000 tons of ore in 1953, as compared to 5,700,000 tons from below ground plus 4,100,000 tons from open pits in 1950. The change is being made without interrupting current output because a major program for the expansion of the underground mining capacity was initiated by the company ten years ago.

Improvements in metallurgical processes and the installation of emergency facilities were included in the program, which has involved the expenditure of around $100,000,000. Results will not be fully realized for about two years, but they are already being felt. An increase of one million pounds of nickel monthly over the 1950 rate was achieved in July of this year and brought monthly production of refined nickel to 21 million pounds—the company's highest peacetime rate.

The U.S. Bureau of Mines has awarded a contract to the Chemical Plants Division of Blaw-Knox Company for the design and construction at Rifle, Colo., of an experimental plant for the continuous extraction of oil from shale. To cost approximately $333,000, it will be based upon a new gas-combustion retorting method developed by the bureau and will process anywhere from 150 to 400 tons of oil shale daily.

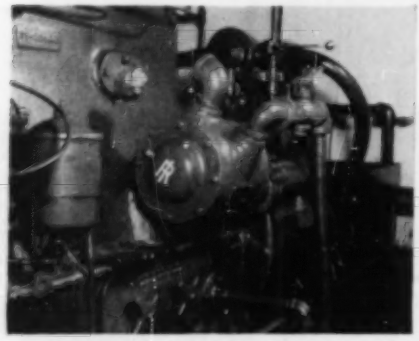
Ropes Serviced in Motion

BY A METHOD developed at the Homestake under the direction of Josiah Gerrans, chief mechanical engineer, all the mine's hoisting ropes are lubricated while they are in motion. The idea is not new, but as applied at the Homestake is said to work effectively. Each rope is first cleaned by compressed air, and is then oiled by means of four spray guns mounted at equidistant points around the rope. Both the lubricant and the air for the guns are heated to about 170°F in a steam heat exchanger. The lubricant enters the exchanger at the top and passes through a 10-inch jacketed pipe section, while the air is introduced at the bottom and flows through a coil.

A light, medium lubricant is used for all except the 150 feet of rope near the cage or skip. This end is given a heavier kind, and it is sometimes necessary to use dry steam as well as compressed air to clean it. Work on the latter section is not done on the day the main rope is being serviced. Each rope is lubricated throughout its entire length every ten days, and the new equipment makes it possible to take care of two in about twenty minutes.

Industrial Notes

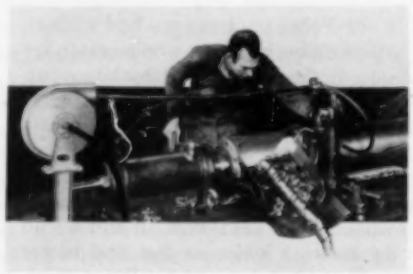
For cranking diesel and gasoline engines with piston displacements up to 3500 cubic inches and more, Ingersoll-Rand Company has developed a line of air starting motors that has a wide field of application in heavy industries including construction, lumbering and mining and in the trucking, petroleum, power and marine fields. The power unit consists of a Multi-Vane air motor with a solid-steel rotor revolving in a cylinder of wear-resistant alloy and enclosed by bronze end plates. The rotor has five vanes for smooth power flow, and ball bearings are used to support all rotating parts to insure long life and trouble-free service. Cranking is said to be reliable and accomplished through a conventional Bendix drive that is engineered to the performance characteristics of the motor. Any mechanic familiar with the maintenance of internal-combustion engines can service and install the unit. Ordinarily powered by compressed air, equal performance is assured when operated with natural gas if available at sufficient pressure. Two basic sizes are furnished: 9-BM and 20-BM which, respectively, develop up to 16 and 41 hp and require approximately 7 and 16 cfm of air per start. The company makes nine models for adaptation to many different engines.



MARINE INSTALLATION

Shown at the right-center is a Size 20-BM air starting motor serving a Buda engine aboard the tug "Captain George." The use of generators, banks of batteries, and electrical accessories such as solenoids and voltage regulators with their high maintenance and replacement costs are eliminated.

Coils of hose lying around loose or draped from overhead are a hazard that is avoidable by the use of retriever hose reels such as are made by The Wayne Pump Company for general industrial use, garages and service stations. Open and enclosed types are available for water, coolant, air, oil or grease hose ranging from a ¼-inch (inside diameter) 15-foot line to ½-inch high-pressure hose 50 feet long. The latest models have a stainless-steel shaft and a newly designed swivel assembly with oil-impregnated bronze bearings and an "O" ring seal. The reel is actuated by a powerful spring, and the hose is held at any desired length until a rotary latch is released by a short pull, which causes it to rewind. Whip, lash, or runaway is prevented by a governor that automatically controls the return speed, and a rubber bumper on the coupling brings the hose to a cushioned stop. A universal mounting bracket permits installing reels on floor, ceiling, wall or column, above or under a bench, wherever most convenient. For servicing trucks and cars with water and air there is a Twin Reel Pit housed in a steel box that can be set flush with the pump island; and in another reel designed for refueling airplanes, for example, provision is made to prevent the accumulation of a dangerous static charge.



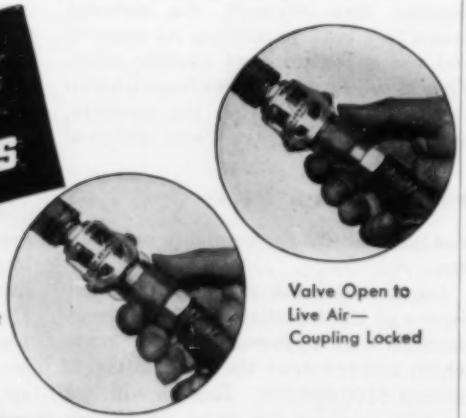
MACHINE-TOOL APPLICATION

This picture shows the retriever hose reel attached to a lathe and supplying coolant to the cutting-tool head. The liquid is fed through the reel to the hose, which follows the movement of the head and leaves no loops in the way to cause accidents.

Vermiculite, which is used in making plasters and boards for insulation against heat, cold and sound, is being applied in a novel way by a fabricator on the West Coast. During periods of nonproduction such as week ends and holidays, a 4-inch layer of the lightweight mineral is put on top of the molten zinc in 60-ton galvanizing kettles and 20 of the 32 gas burners are turned off. In this way a lot of fuel is saved and the metal is kept at the desired temperature. The blanket costs little, because it can be scraped off and reused.

Clearing timberlands by a single saw at the rate of five acres in an 8-hour day where the stands are dense and ten acres where light, sounds fantastic, but that is being done, we are told, by a group of contractors on the U.S. Bureau of Reclamation's Boysen Dam Project. This

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves



Valve Closed to Live Air— Open to Exhaust

Valve Open to Live Air— Coupling Locked

VALVE COUPLINGS ¼", ⅜", ½", & ¾" SIZES

For Economy and Safety

● These couplings permit air to be shut off and tools changed quickly without going to the main shut-off valve. Coupling jaws are automatically self-locking when valve is open to air supply. The coupling cannot be disconnected until the valve sleeve is moved to closed and exhaust position,— thus preventing accidents and injuries. Pressures to 250 p.s.i.—hose shank, male or female pipe connections. *Send for Bulletin No. 104-C. It gives full details and prices.*

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

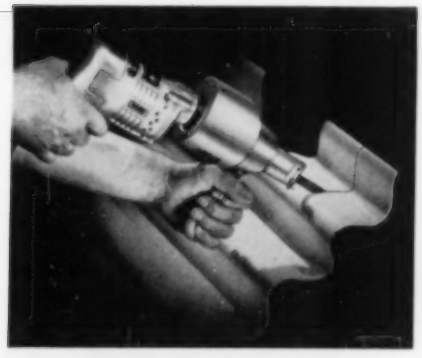
Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 2036 East Pershing St., Salem, Ohio

herculean performance is attributed to a 6-foot-long saw bolted to the blade of a bulldozer. With its flat, V-shaped, toothed steel plate and central stiffening rib tapering from front to back, it looks much like the head of a sawfish. Guiding his bulldozer so that the tip of the cutting edge strikes the tree, the operator drives the machine ahead to force the saw through the trunk, felling cottonwoods as much as 24 inches in diameter in one pass. A heavy steel frame protects the operator from falling timber. The saw is set close to the ground to make a clean cut, and the teeth are fine or coarse to meet varying needs. Another bulldozer, fitted with a heavy rake whose tines extend 8 inches below the blade, clears away the trees and underbrush.

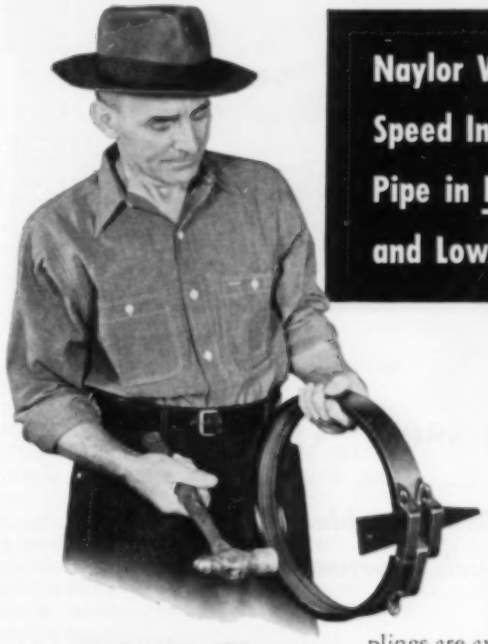
Maintenance and repair men, plumbers, carpenters, and production men generally have at their disposal a new hand tool, the E-Z Saw, that is designed to lighten their labors while speeding up operations. It is attached directly to an air or electric drill or a flexible shaft and converts the rotary action of the power unit into a fast reciprocating motion. The tool can be used either as a saw or a file by inserting an ordinary hacksaw or



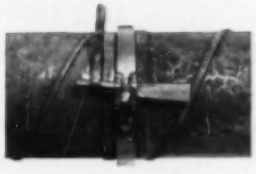
a machine file into the holder and operates with a ⅞-inch stroke. A full-length cutting blade can be used to reach hard-to-get-at places, and special blades are available for very heavy work. The handle is adjustable—can be turned and locked in any desired position. According to the E-Z Way Tool Company, the saw quickly cuts through all metals, including corrugated stock, as well as wood, plastics, and other materials.

By a new method of descaling forgings, which eliminates sandblasting, it is possible to effect savings up to 90 percent, says the Pennsylvania Salt Manufacturing Company, which is responsible for the new treatment. The concern has prepared a compound called Pennsalt SR-4 that is mixed with weak muriatic acid and water. The forging, placed in a sheet-iron basket, is immersed in the solution for five minutes, heat-treated, and then dipped in water. There, according to reports, the oxide

Short Cut to Pipe Connections



Naylor Wedge-Lock Couplings Speed Installation of Naylor Pipe in Both Heavy-Duty and Low Pressure Service

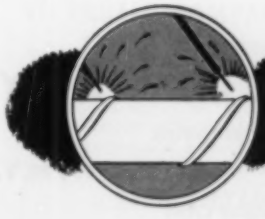


Whether it's a permanent, heavy-duty installation, or a temporary, low-pressure line, there's a Naylor Wedge-Lock Coupling that's ideal for connecting Naylor pipe.

These positive type couplings are available in two types—for heavy duty and for low pressure. They provide the quickest, easiest and most economical method of pipe assembly, and a hammer is the only tool required.

The Naylor Wedge-Lock one-piece construction offers definite advantages. Joints can be made up with only one side of the line in the open. The coupling also provides for expansion and contraction. It assures tight, leakfree joints, less power loss, long service life, high salvage and re-use value. Available in sizes for light-weight pipe from 8″ to 30″ in diameter.

Write for Bulletin No. 513 on Heavy-Duty type; or Bulletin No. 514 for Low-Pressure Coupling.



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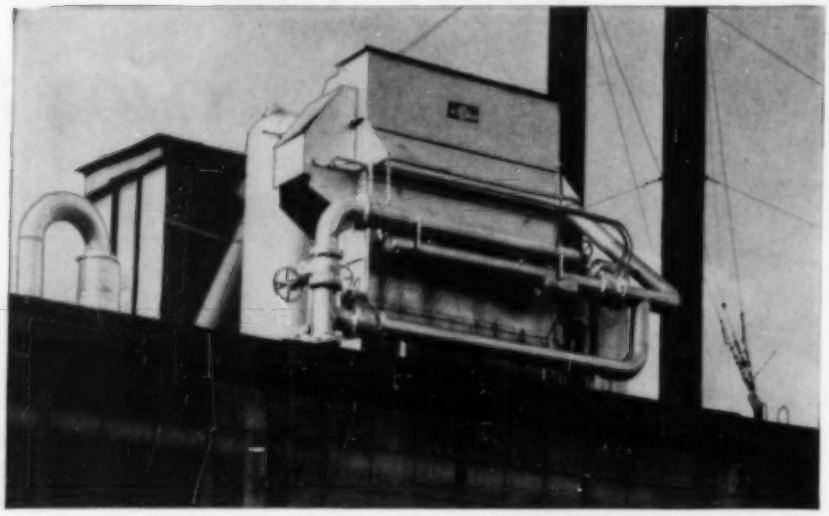
Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

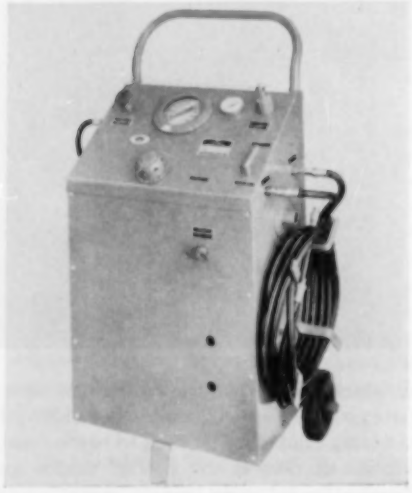
Dept. CA, 405 Lexington Ave. New York 17, N. Y.

Experienced District Engineers in all Principal Cities

scales fairly shoot away from the steel, leaving the surfaces clean for machining. The process has been used satisfactorily on grades of carbon steel and some alloy steels.

Repairs to holes or breaks in concrete floors can be made quickly during working hours, it is claimed, by a new quick-setting cement called Por-Rok. Mixed with water, it is poured into cleaned-out openings and requires no troweling. According to the maker, The Hallemite Manufacturing Company, the patches are ready for light loads in fifteen minutes and for the heaviest kind of loads within an hour. The material has a compression strength of 4500 psi.

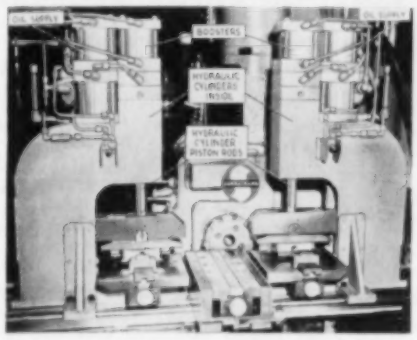
Though designed primarily for use in connection with aircraft, Sprague Engineering & Sales' new hydraulic power unit is suitable for testing all types of hydraulic components and systems within its capacity range of 500-5000 psi. A pneumatic boost pump taking air from a plant line supplies the energy to operate the apparatus, which can be wheeled right to an airplane for operational or static testing, or anywhere in a factory for checking components on the spot,



thus eliminating the use of expensive stationary stands that disrupt normal volume-inspection schedules. Known as the Model S-404, it comes complete with instruments and controls and is available with a single or a double hose outlet. The unit is housed in a steel cabinet mounted on rubber-tired wheels.

Ease of operation and time and labor saving are advantages claimed for a universal-type clamping fixture built especially by the Planet Products Corporation for the Sundstrand Rigidmil, which handles work pieces ranging from approximately 2 inches square and 1 inch thick to 20 inches square and 5 inches thick. The fixture, which is actually two clamping units facing each other, is designed for the reciprocal milling of two

small parts or one large part, which is kept level automatically through contact between a serrated reaction shoe and a mating reaction plate. Each half consists of a Miller Air Miser fluid pressure booster with a ratio of 25 to 1, of a Miller high-pressure (2000-3500 psi) hydraulic cylinder, of an oil-supply tank and of an on-off switch. When the latter is moved to the "on" position, compressed air



from the shop line is admitting into the tank, forcing the oil through the booster by-pass into the hydraulic cylinder, giving the piston a low-pressure stroke. As soon as the piston is in contact with the workpiece, the high-pressure oil from the booster is automatically cut into the system and provides the clamping pressure needed to hold the work during the milling operation. With input air at 80 psi, a total clamping force of 10,000 psi is obtained. This can be varied as desired by lowering or increasing the air pressure.

Although titanium is one of the earth's most abundant elements, it has not been available in large quantities because it is difficult to extract. However, production has grown from a few laboratory samples in 1946 to 550,000 pounds in 1950. There also is a possibility that the price may be reduced from the present $5 to $7 a pound to $1, according to a report from Horizons Titanium Corporation, a new organization. The latter has been experimenting with a continuous rather than a batch process of making the metal and is now ready to proceed to the pilot-plant stage.

Some time ago National Tube Company began a research program with the aim of providing steel casing that would be strong and tough enough to withstand the great pressures to which it is subjected at the ever-increasing depth to which oil wells are being carried. The result is a quenched and drawn carbon-manganese steel which, in the case of 7-inch casing (outside diameter), is said to have a minimum yield strength of 110,000 psi at 0.6 percent total strain, an average ultimate strength of 139,000 psi, and an average elongation of 22.4 percent in 2 inches. The improved casing is in production at the company's McKeesport, Pa., plant.

WORLD'S BEST METHOD FOR PIPING

The Victaulic name stands for pioneering and world leadership in quick, dependable piping construction. Victaulic offers a *complete method* of piping that just can't be beat! From one end of the line to the other... for almost every kind of piping job... you'll find that Victaulic's the EASIEST WAY TO MAKE ENDS MEET!

Victaulic is *not* just a quick way to hook up pipe line sections... it's a COMPLETE METHOD with a versatile line of Couplings, Full-Flow Elbows, Tees, and other Fittings. Victaulic offers wide adaptability and makes joining those pipe ends quick, easy, and economical. A simple two-bolt coupling brings pipe ends together in a jiffy; a speed or T-wrench is the only tool required. AND the Victaulic Method assures positive-locked, leak-proof joints even under extreme pressure, vacuum, or strain conditions.

Preparing pipe ends is a cinch with the "Vic" Method..."Vic-Groover" grooves 'em automatically, twice as fast as a conventional pipe threader!

On *your* next piping job — new construction, repairs, or alterations — try the Victaulic Method and you'll save time, work, and money!

Make that next piping job ALL VICTAULIC! Write today for Victaulic Catalog and Engineering Manual No. 44-8B

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Phone: Elizabeth 4-2141
Victaulic Inc., 727 W. 7th St., Los Angeles 14, Calif.
Victaulic Company of Canada, Ltd., 406 Hopewell Ave., Toronto10
For Export outside U.S. & Canada: PIPECO Couplings & Fittings, Pipe Couplings, Inc., 30 Rockefeller Plaza, New York 20, N.Y.
27TH VICTAULIC YEAR

The easiest way to make ends meet
VICTAULIC
PIPE COUPLINGS AND FITTINGS

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Books and Industrial Literature

The Heat Exchange Institute now has ready for distribution the third edition of *Standards for Barometric and Low Level Jet Condensers*. This publication covers nomenclature, types, design, performance, construction, installation and other features of these units that effect the condensation of vapors by means of direct contact with the condensing water. Calculations, data sheets and conversion tables make it a handy reference book. Published by the Heat Exchange Institute, 122 East 42nd Street, New York 17, N. Y. Price, $1.00.

Lefax announces a series of fifteen revised Dollar Data Books for engineers in the following mechanical fields: Aeronautics, No. 619; Air Conditioning, No. 638; Automotive Engineering, No. 602; Diesel Engineering, No. 640; Home Heating, No. 610; Machine Design, No. 606; Machinists' Data, No. 636; Mechanical Drawing, No. 617; Mechanics of Materials, No. 635; Metals, No. 621; Piping Data, No. 653; Power Transmission Machinery, No. 633; Steam Engineering, No. 620; Thermodynamic Tables and Charts, No. 634; and Welding Data, No. 645. All are of pocket size and contain approximately 140 loose-leaf pages of authoritative and up-to-date information. Published by Lefax, Philadelphia 7, Pa. Price $1, postpaid.

The U. S. Bureau of Reclamation has published an illustrated booklet in answer to the increasing number of requests for information from the United States and foreign countries about its Engineering Center at Denver, Colo., and the technical facilities available there. The Center maintains a library containing detailed studies of engineering problems encountered by the Bureau in its half century of planning and constructing the world's largest dams, reservoirs, hydroelectric plants and water-distribution systems. Included among its more than $2,000,000 worth of laboratory equipment is a testing machine capable of exerting a maximum pressure of 5,000,000 pounds on specimens up to 32 feet high, as well as special machinery for model making and research. The booklet tells something about the technical assistance the Center renders at cost whenever it is possible to do so without interfering with the Bureau's programs. It may be obtained from L. N. McClellan, Chief Engineer and Director, Branch of Design and Construction, Bureau of Reclamation, Denver Federal Center, Denver, Colo., or from the Commissioner of Reclamation, U. S. Department of the Interior, Washington 25, D. C.

A bulletin—No. 712—containing complete punch and shear capacity charts and detailed information on Kling punches can be obtained by writing Kling Bros. Engineering Works, 1320 N. Kostner Street, Chicago 51, Ill.

Bulletin PPY-1 distributed by Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Ill., discusses two portable pyrometer models for plant and laboratory use and contains specifications on its thermocouple holders and tips.

Sarco Company, Inc., Empire State Building, New York 1, N.Y., has published a booklet titled *How Increasing Your Steam Costs Can Save Money*. It asks and answers sixteen questions in that vein and is written to give executives, who are not familiar with the subject, a good understanding of it.

The Armstrong Machine Works, 213 Maple Street, Three Rivers, Mich., has issued a 12-page catalogue on its steam traps and air traps. Among other features, it contains a 4-page section giving data on calculating condensate loads and selecting traps to handle the loads.

A technical booklet has been released by the Electric Machinery Mfg. Company, Minneapolis 13, Minn., that contains complete information on its magnetic drive and magnetic amplifier Regutron speed control for a-c motors. Ask for Publication 1107.

A new Morse Chain Company catalogue —No. C 55-50—dealing with its line of stock roller chains and sprockets has recently been issued and can be obtained from the company at 7601 Central Avenue, Detroit 8, Mich. The booklet includes helpful data on drive selections, service factors and installations.

"If bombs—atomic or otherwise—fall in the vicinity of your plant, what would happen? How would your employees react to the wail of the alarm siren? Would there be panic? Would machinery be left running? Could processing hazards, left unattended start destructive fires, even though bombs caused no direct plant damage?" These

FRONT VIEW shows crimping blade and adjustable heated jaws; air and thermostat controls mounted at left.
REAR VIEW shows NOPAK Model "E" 4" x 8" stroke Cylinder, with self-regulating cushion at both ends.

Leather Crimping Machine

Air-Powered by NOPAK Cylinder

The crimping machine pictured was developed by Western Supplies Co. of St. Louis. It "makes shoes fit better" because it preforms leather upper sections, under heat and pressure, so that they can be subsequently drawn snugly against the lasts.

NOPAK Air Cylinder Power was chosen to reduce operator fatigue and increase production . . . to utilize controlled line pressure over the full range of crimping operations . . . to eliminate working parts . . . and because NOPAK mounting characteristics were best fitted to the machine. A study of the cylinder's construction indicated there was "practically nothing to wear out." It was also found to meet the high standards required at a comparatively low price.

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2759 S. 31st St. • Milwaukee 46, Wis.
Representatives in Principal Cities.

Write for Bulletin SW-1 or refer to Sweet's File for Product Designers.

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

provocative questions are in a 32-page illustrated booklet on *How to Prepare Your Plant for Atomic Attack*. It is offered without cost by Walter Kidde & Company, Inc., Dept. A, 675 Main Street, Belleville 9, N.J., and serves as a guide to plant managements.

A 6-page folder describing vibration fatigue testers and pointing out the advantages of checking manufactured products for weaknesses in design and selecting materials for given jobs is obtainable from the All American Tool & Manufacturing Company, 1014 West Fullerton Avenue, Chicago 14, Ill.

The Steel & Tubes Division of Republic Steel Corporation, 224 E. 131st Street, Cleveland 8, Ohio, is offering a folder descriptive of its decoron-coated Electrunite, a new electrical metallic tubing for the protection of wiring systems that are exposed to the action of fumes, gases and other corrosives.

In a 30-page booklet designed as a guide in selecting electrical measuring instruments, Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pa., explains seven basic selection factors, gives types of instruments available, and works out typical problems. The booklet, B-4696, is obtainable upon request.

A pictorial catalogue showing American Revolver Cranes working at docks and different industrial plants throughout the world should interest persons faced with large-scale materials-handling problems. The 19-page publication includes short job stories and can be obtained by writing to American Hoist & Derrick Company, 63 South Robert Street, St. Paul 1, Minn.

As an aid to manufacturers operating under the Controlled Materials Plan, Remington Rand Inc., 315 Fourth Avenue, New York 10, N. Y., has released a manual outlining methods for streamlining clerical routine and setting up and controlling records. Other functions necessary to efficient operation are also considered. Request booklet X-1203, *Record Research Report on CMP* from the Management Controls Division.

Those with pumping problems that involve taking water from open sources such as in dewatering, cooling tower and other bulk-liquid transfer operations will be interested in a new 8-page catalogue obtainable from Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y. The booklet deals with its Class APH-APK vertical turbine-type pumps that are available in single- and multistage construction, in sizes varying from 6 to 30 inches, for capacities to 15,000 gpm, and pressures to 250 psi. Write for Catalogue 7228.

How Modern Stamping Techniques Can Help Conversion is the title of an illustrated paper presented at the Pressed Metal Institute by James M. Leake, president of The Leake Stamping Company, 1250 E. First Street, Monroe, Mich. It gives an insight into the scope of the industry and points out how manufacturers who use its products can effect speed-ups and cost savings by a better understanding of the field of "creative" metal stampings. Reprints are available if requests are written upon company letterheads.

A Y-type reversing cold strip mill built under license agreement by Mackintosh-Hemphill Company, Ninth and Bingham streets, Pittsburgh 3, Pa., is described in detail in an illustrated 16-page booklet, Bulletin No. 1D51, that can be obtained by anyone interested. The new mill is available in widths ranging from 16 to 66 inches or larger for cold rolling all grades of steel, brass, copper, aluminum, etc. It is said to be the first of its kind to successfully combine the advantages of small-diameter work rolls with the power required for deep draft and high speed.

Gas Turbine for Gas-Pipeline Pumping is the title of a new booklet issued by General Electric Company, Schenectady 5, N. Y. Those interested in this prime mover for centrifugal compressors will find much helpful information in the 15-page catalogue on the general features of the equipment, its application and operation. Among the numerous illustrations are charts and sketches showing the components of the turbine, horsepower limits for various ambient temperatures and typical installations. A section deals with accessories and control equipment, including remote supervisory control. Publication GEA-5530 will be mailed upon request.

Stainless Steel Handbook tabulates for easy reference the important properties of more than 30 types of stainless steel and is a handy reference work for fabricators and design engineers. Clothbound, one section of the 120-page book is devoted to the selecting of stainless for given applications, while other chapters discuss each type separately, giving specific information about heat treating, fabrication and special conditions in service. Allegheny Ludlum Steel Corporation, 2020 Oliver Building, Pittsburgh 22, Pa., will furnish the book upon request.

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Longer Engine Life

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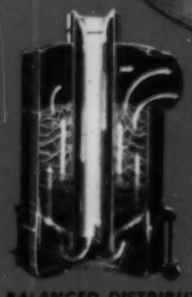

BALANCED DISTRIBUTION of oil across the entire lower element, eliminates both "overloaded" and "thin" areas.

Extra-heavy-duty Donaldson Air Cleaners now hold a series of conical wire-mesh-screen "trays" in the scrubbing area. This design feeds more of the condensed oil back into the air stream as it leaves the center tube. The result, proved in five years of laboratory and field tests, is higher cleaning efficiency and greater dirt-holding capacity. Only Donaldson has this new "tray-type" cleaner. We invite manufacturers to write or call for design data and test reports.

DONALDSON COMPANY, INC.
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Donaldson AIR CLEANERS

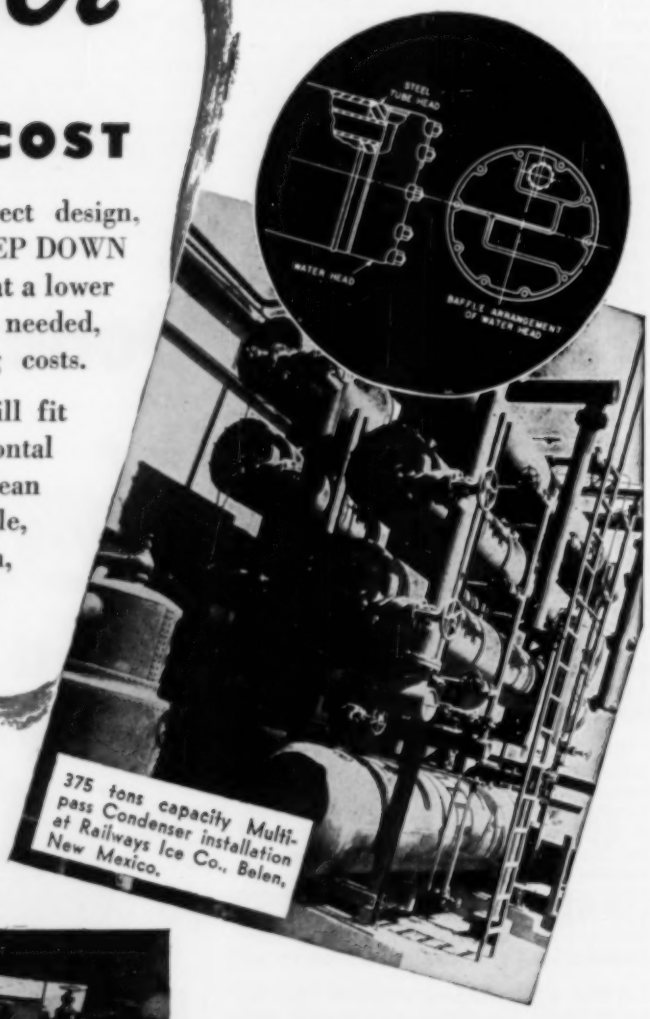
$ave Power and REFRIGERATION COST

Vogt Condensers, because of their correct design, STEP UP the rate of heat transfer and STEP DOWN head pressures. With the liquid delivered at a lower temperature, smaller compressor capacity is needed, saving in original as well as operating costs.

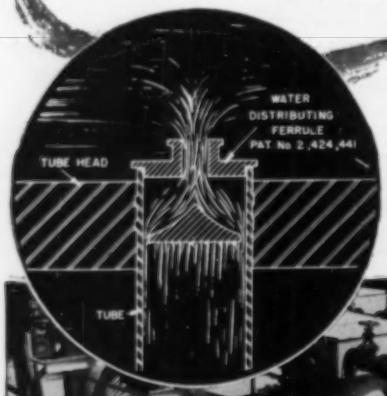
One of the two basic types illustrated will fit your operations exactly. Install Horizontal Multipass (closed type) for use with clean waters. Where the water is hard, forms scale, contains mud or promotes fungus growth, Vertical Single Pass (film type) which can be cleaned in operation, are recommended.

Horizontal Multipass Condensers
(Closed Type)

Water circulated in tubes traverses the length of the unit a number of times as determined by baffles in the heads.

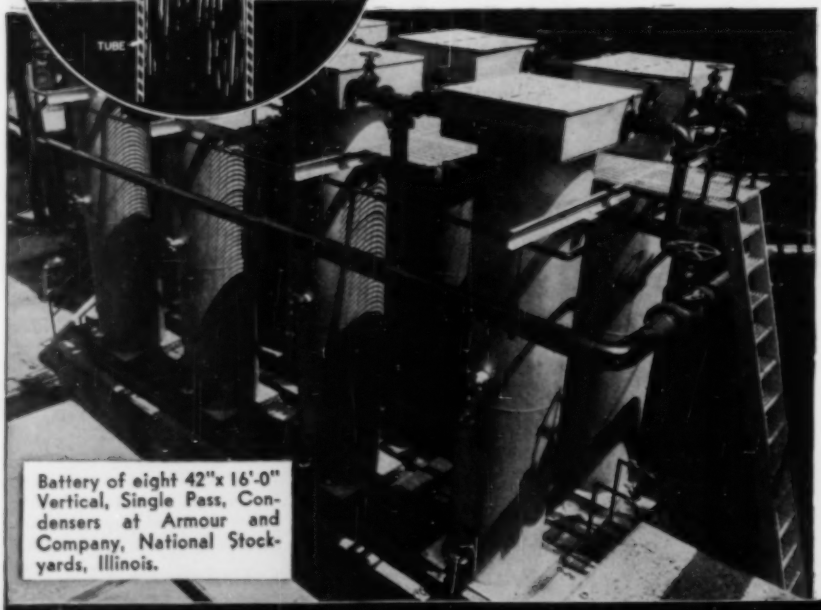


375 tons capacity Multipass Condenser installation at Railways Ice Co., Belen, New Mexico.



Vertical Single Pass Condensers
(Film Type)

Patented ferrules give equal distribution of water to and over the surfaces of all tubes in a unit.



Battery of eight 42"x 16'-0" Vertical, Single Pass, Condensers at Armour and Company, National Stockyards, Illinois.

HORIZONTAL and VERTICAL TYPES SHELL and TUBE CONDENSERS For Every Service

Write For Bulletin RC-1

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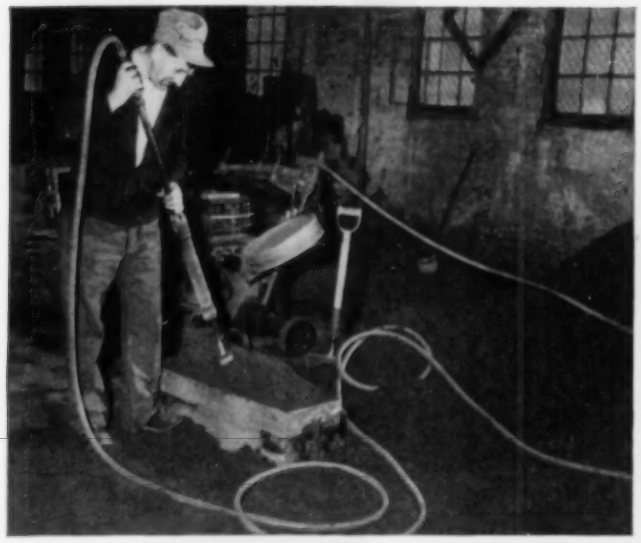
1000 W. ORMSBY ST., LOUISVILLE 10, KY., U.S.A.
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Vogt REFRIGERATION CONDENSERS

RESEARCH KEEPS **B.F.Goodrich** FIRST IN RUBBER



One air hose for these four jobs and hundreds more

B. F. Goodrich Type 50 meets 85% of all air hose needs

HERE is the most useful air hose made. It is the B. F. Goodrich Type 50 for shop tools, tampers, fixed and portable compressors, air hoists, quarry and mining service. In fact, BFG Type 50 does 85 out of every 100 air hose jobs, and lasts longer in doing them.

Saves waiting — In normal times every B. F. Goodrich distributor has Type 50 hose for immediate delivery. You don't have to wait for special kinds of hose; you don't hold up important production. Even in periods of shortage it may save you time because your distributor can often get it for you more quickly.

Oil won't rot it — This Type 50 air hose has a tube that won't break into loose, gummy particles to clog up tools. The cover is oil-resisting too. Workers with oily hands or gloves can handle it, use it near oily machines and surfaces.

Rough treatment won't tear it — On almost any job, air hose has to be dragged over rough surfaces, with danger of costly tears, breaks, snags. The cover of B. F. Goodrich Type 50 air hose is abrasion-resisting. Scraping over rock, rough floors, cinders or roads won't tear it. Won't check or crack from constant sunlight.

Your local BFG distributor has all the details and prices on Type 50 air hose. Call him, or write *The B. F. Goodrich Company, Industrial and General Products Division, Akron, O.*

Air Hose BY **B.F.Goodrich**

only FLUOR offers this selection

A CHOICE OF TWO PULSATION DAMPENERS TO SOLVE YOUR PARTICULAR PROBLEM!

A FUNDAMENTAL PULSATION DAMPENER

A HIGHER FREQUENCY PULSATION DAMPENER

In 1943, The Fluor Corporation pioneered the development of pulsation dampeners. The first U. S. Patent covering pulsation dampeners designed specifically for the removal of gas stream pulsation and subsequent vibration in compressor piping was issued to Fluor in 1946.

Continued research in gas pulsation and its associated problems has established that pulsation, and its intricate secondary vibration, can be attributed to both fundamental and high frequency pulsations *—or to high frequency components alone.*

Whichever of these destructive conditions exists in your plant, Fluor offers a dampener engineered to fit the requirements of the specific problem. Fluor—and only Fluor—offers such a complete range of pulsation dampeners. For this reason you can be assured of an unbiased recommendation on the best type dampener for your *particular* requirements.

THE FLUOR FUNDAMENTAL PULSATION DAMPENER

This type dampener smooths out all pulsations in the gas stream to the extent of at least 85%. All harmonics originally set up in each pulse cycle are automatically reduced or eliminated. This dampener is the guaranteed answer in plants where structural vibration and metering difficulties are encountered irrespective of pulsation frequency.

MAKE YOUR OWN PRELIMINARY SURVEY

In many cases you can make your own preliminary survey to determine roughly if your pipe vibration is caused by pulsations. Write The Fluor Corporation, Ltd., Los Angeles 22, California, indicating layout of compressor house piping and operating pressures. A procedure will be mailed to you promptly. No obligation.

THE FLUOR HIGHER FREQUENCY PULSATION DAMPENER

This dampener removes objectionable pulsation frequencies encountered above the fundamental. In many instances, it has been found that metering difficulties and vibration of compressor piping and nearby vessels have been caused by the higher frequency components alone. Available in both manifold and in-line types, this dampener is competitive in cost with muffler or snubber type devices.

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TECHNICAL PAPERS *on the subject of* GAS PULSATION

BY ENGINEERS OF THE FLUOR CORPORATION

"Pulsation Phenomena in Gas Compression Systems"
By I. C. Bechtold, *Director of Research and Development*

Abstract: *Pulsation phenomena in gas transmission lines leading to and from gas compressor stations are described along with a description of the mechanical vibration induced from the pulsative flow.*

"Effect of Pulsation on Gas Measurement"
By C. F. Yates, *Research Engineer*

Abstract: *This paper discusses the effect of pulsative flow on the accuracy of measuring gas flow rate by orifice meters. Data are presented showing the relationship between magnitude and nature of the pulse and the resultant readings recorded by the measuring instrument.*

"Mechanical Vibration of Piping Induced by Gas-Pressure Pulsations"
By R. C. Baird, *Research Engineer, and* I. C. Bechtold, *Director of Research and Development*

Abstract: *The generation and nature of gas-pressure pulses from reciprocating compressor action are described, together with the propagation of such pulses through pipe lines. The means whereby pulse energy is converted to mechanical vibration is discussed by the aid of analogous mechanical, acoustical, and electrical oscillatory systems. The economic importance of minimizing vibration in compressor and compressor-dependent installations is indicated.*

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DESIGNERS AND CONSTRUCTORS of Refinery, Natural Gas and Chemical Processing Plants.
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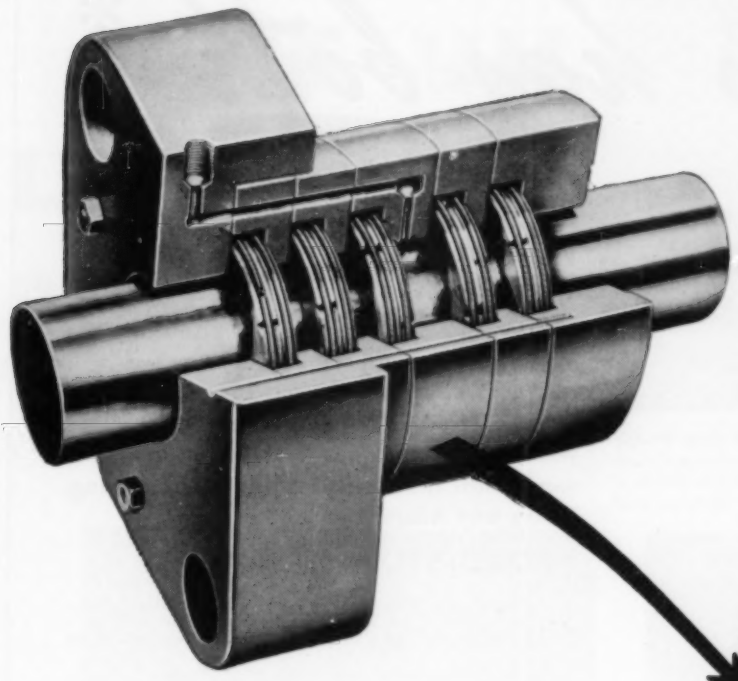
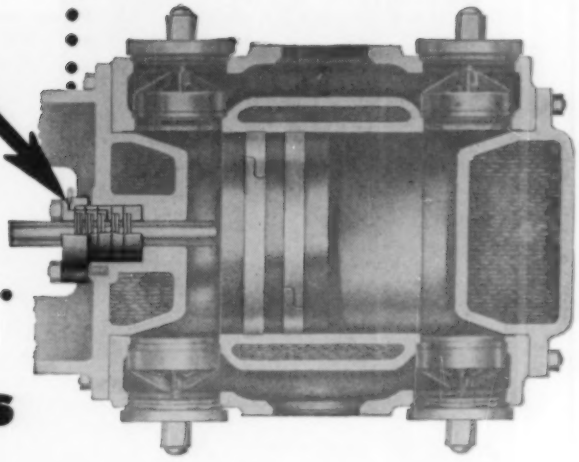


MODERN PACKINGS *for* MODERN COMPRESSORS



COOK
Metallic Rod Packings

More and more compressors are being designed to utilize all modern developments that tend to make the units more efficient and dependable.

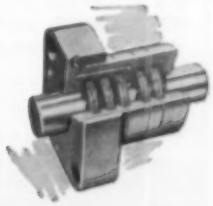
Thus, it is only natural so many manufacturers have selected Cook full-floating, all-metallic packings as the modern method of sealing the piston rods.

In Cook Packings the rings are made of anti-friction metals. The packing design keeps friction and wear to a minimum by automatically compensating for rod misalignment and vibration—and by permitting the use of approved methods of lubrication. In every detail Cook Packings represent a definite improvement over ordinary rod seals.

Make sure your new compressor is equipped with this modern rod seal. Specify Cook by name when you order new equipment.

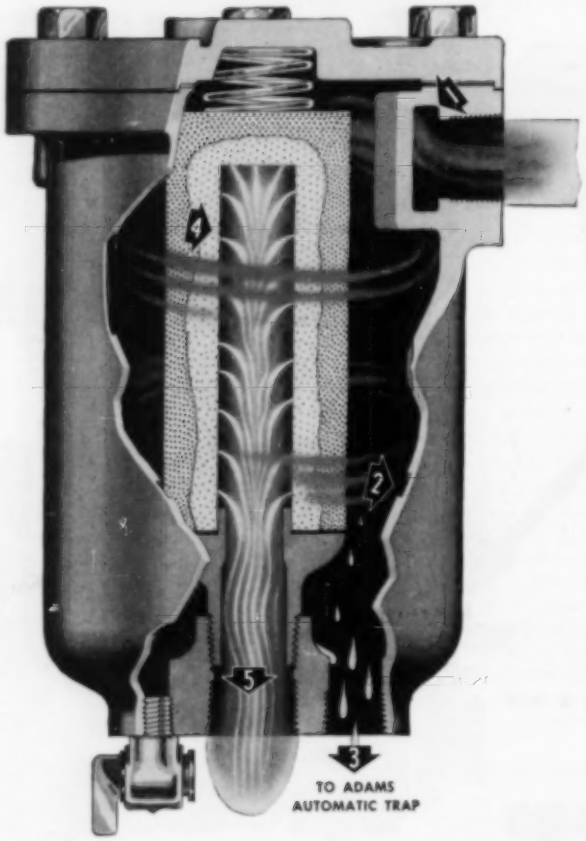
C. Lee Cook Mfg. Co., Incorporated, Louisville, Ky. Branch offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

COOK GRAPHITIC IRON
ROD PACKINGS



. . . SEALING PRESSURES SINCE 1888 . . .

ADAMS *has both* *



—— BOTH ANSWERS TO THE PROBLEM OF KEEPING WATER, WATER VAPOR, OIL AND DIRT OUT OF COMPRESSED AIR LINES

There's no *one* answer to this problem! The most expensive aftercooler you can buy will not remove scale that is picked up in the distribution lines. The most expensive air filter you can buy cannot guarantee removal of water vapor until it has been condensed by cooling. That's why Adams makes both.

* PORO-STONE *AIR FILTER*

1. Centrifugal separation of dirt and liquids.
2. Drainage to trap directed by vertical cast-in slots.
3. Continuous, fully automatic trap action.
4. Rapid diffusion and filtration through permanent, cleanable Poro-Stone.
5. Clean, dry air at practically unchanged pressure. Standard, stocked sizes handle from 10 to 700 cfm.

Easily installed in either vertical or horizontal pipe line.

* *AFTERCOOLER AND CYCLONE SEPARATOR*

Cools air to within a few degrees of cooling water, making certain that compressed air is colder than surrounding atmosphere, so that no further condensation can take place.

Counter flow, air-through-tube design assures continuously high heat transfer rate.

Double cyclonic action deposits all water and entrained oil in special moisture chamber.

R. P. ADAMS CO., INC.
209 E. Park Drive, Buffalo 17, New York

Please send me your latest literature, Bulletin No. 176 on BOTH the Poro-Stone air filter and the Adams Aftercooler — Cyclone Separator.

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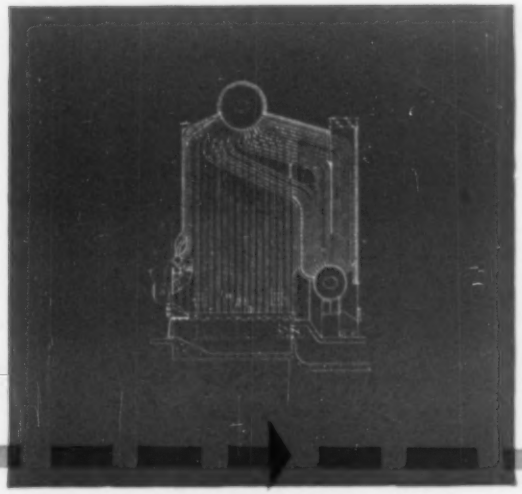
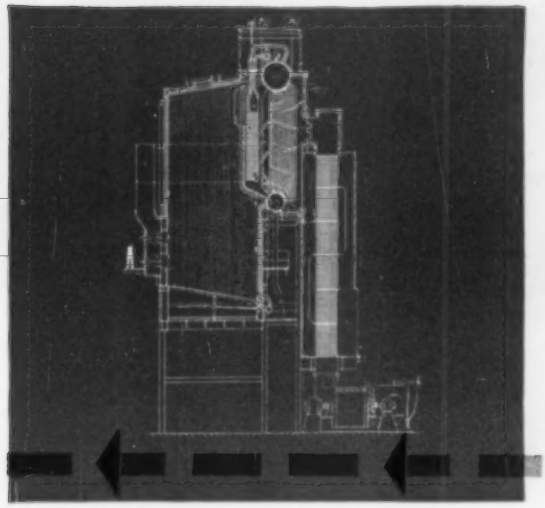
FOR YOUR PROFIT'S SAKE — FIND OUT ABOUT BOTH

R. P. ADAMS CO., INC., BUFFALO 17, N. Y.

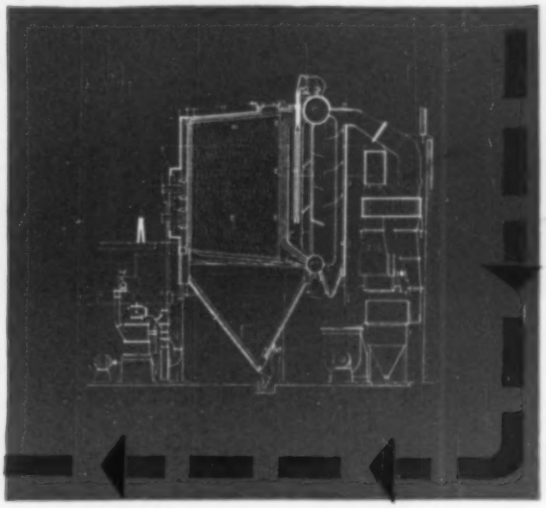
ONE VU LEADS TO ANOTHER



VU-10 Unit fired with C-E Spreader Stoker (dumping grate type). VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hr. May also be fired by underfeed or chain grate stokers, or by oil or gas.



VU-50 Unit fired with natural gas or oil. Design provides for future pulverized coal firing. Capacity of unit shown is 350,000 lb of steam per hr; operating press.—920 psi; steam temp.—905F.



VU-50 Unit fired with pulverized coal using C-E Raymond Bowl Mills. The capacity of unit shown is 150,000 lb of steam per hr; operating pressure—600 psi; steam temperature—700F.

When VU Boilers were first put on the market, *all* of them, quite naturally, had to be *sold*. Now a very substantial percentage are *bought*. Bought by companies that know by their own first-hand experience what they can expect in day-in and day-out performance—for example:

A paper company some years ago, in urgent need of more capacity, purchased a VU Unit. It went on the line, and—under wartime demand—*stayed there* for 432 days without a shutdown. What do you think they bought when next in the market in 1946? That's right . . . another VU (much bigger than the first).

An automobile company installed its first VU Units (2) in 1947. Two more were ordered for another of its plants in 1948; then three more units for a third plant in 1949 and two more for still another plant in 1950.

A refinery ordered its first VU Unit in 1937. In 1941 another was installed and still another in 1950. For another of its plants two units were ordered in 1942 and a third in 1947.

An electric utility company installed its first VU Unit in 1941. Two more units were ordered for another of its plants in 1947, a unit for a third plant in 1946 and still another for a fourth station in 1949.

* * *

And so it goes—in all sections of the country—and abroad—industry after industry ordering and *reordering* VU Boilers. There must be a reason—and there is. The VU's advanced design, rugged construction and consistent reliability have become a service-proved answer to lower steam costs. You can choose VU with confidence based on the experience of companies in *your* industry, in *your* area.

B-485A

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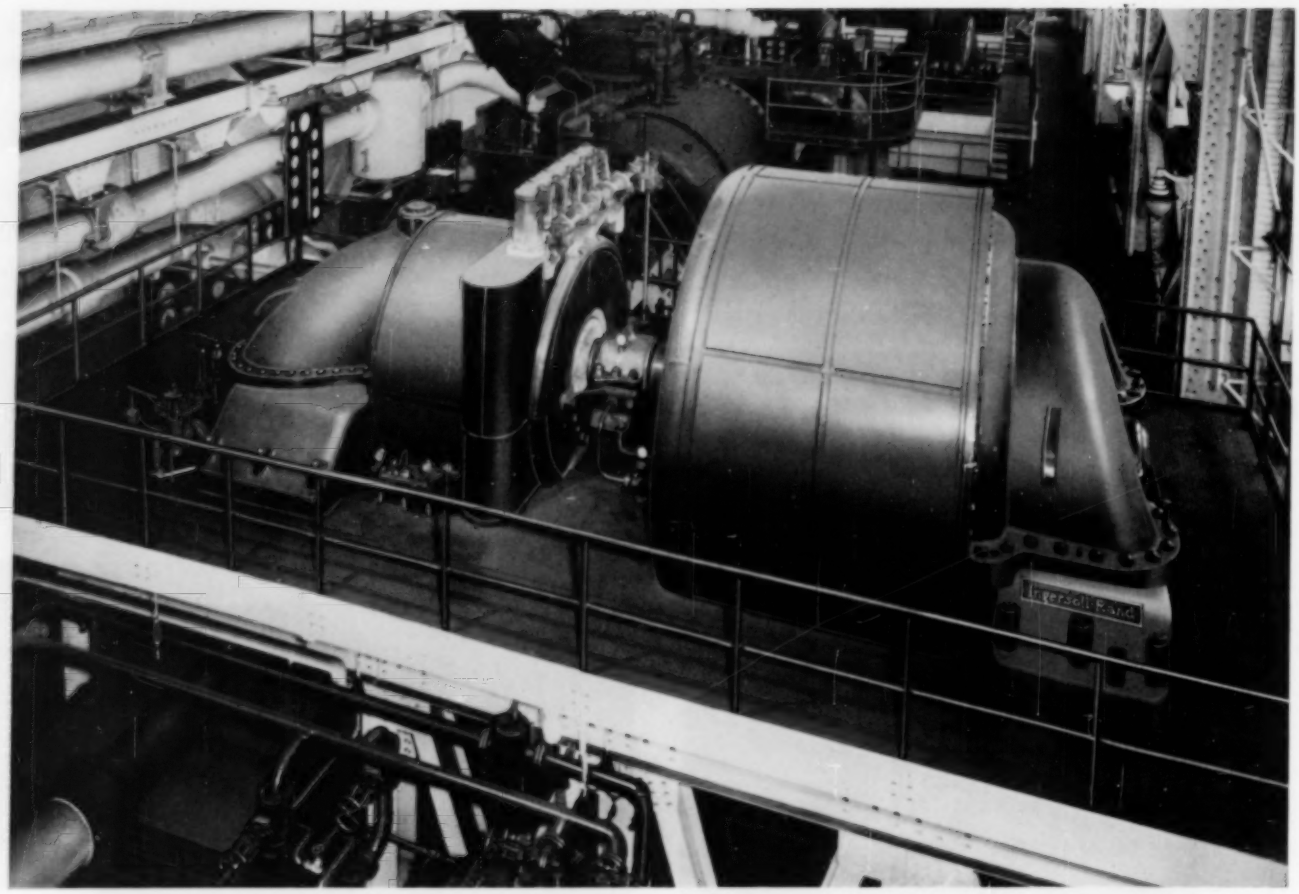
ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



Here's why Ford Motor Co. uses Ingersoll-Rand Turbo-Blowers

This Ingersoll-Rand Turbo-Blower went on line January 17, 1949 and, because of the national emergency, has been running continuously since. As of today (6-15-51) it has been running 24 hours a day for 879 days. This is a good record but not unusual for I-R blowers. They're built to stay on line.

It serves #3 Blast Furnace at the Ford Motor Co.'s Rouge Plant, Dearborn, Michigan. The unit is rated 100,000 cfm and 30 psig. It is driven by an I-R 11,150 hp steam turbine which is served by an Ingersoll-Rand surface condenser containing 4700 sq ft of condensing surface. The condenser is served by Ingersoll-Rand air ejectors, condensate and circulating water pumps.

Once started a Blast Furnace should never be shut down until it needs relining. And to keep it "alive," air must be supplied continuously—night and day, month after month.

Blast Furnace operators know they can't afford to take any chances on the dependability of their blowing equipment. It is significant that Ingersoll-Rand has more than 1,500,000 horsepower of heavy-duty Blast Furnace Turbo-Blowers in operation.

This unequalled experience in Turbo-Blower design and manufacture is your best assurance of maximum availability, plus minimum power and maintenance costs.

Your nearest I-R representative will be glad to discuss your problem of compressing large volumes of air or gas to moderate pressures.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 668-12

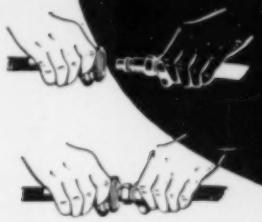
COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS
DIESEL AND GAS ENGINES

IF YOU HAVE FLUID LINES TO CONNECT

YOU'LL SAVE TIME AND TROUBLE WITH

HANSEN

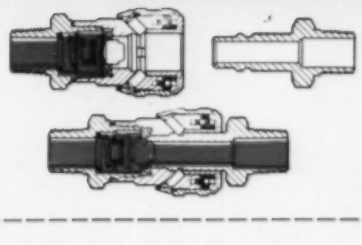
QUICK • CONNECTIVE COUPLINGS



HANSEN PUSH-TITE COUPLING

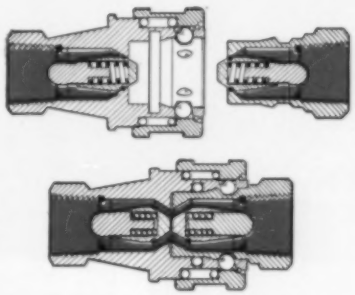
Shuts off one side of line

Gives quick connection and disconnection, with instant automatic flow or shut-off. To connect coupling, and open line to flow of fluid, merely push plug into socket. To disconnect, a slight pull on sleeve releases plug and shuts off supply end of line.



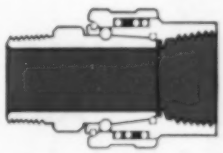
HANSEN HIGH PRESSURE TWO-WAY SHUT-OFF COUPLING

To connect, pull back sleeve and push plug into socket. Identical torpedo type valves permit free flow of gas or liquid through coupling. To disconnect, pull back sleeve..coupling immediately disconnects, valves automatically seal both ends of line. Can be mounted to disconnect automatically where fluid lines may be subject to sudden, damaging strain.



HANSEN STRAIGHT-THROUGH COUPLING

Provides quick connection and disconnection, but does not have shut-off feature. Size range for general use from ¼" to 2½". Two special types of straight-through steam couplings also available—one for low pressures, and one for high pressures.



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Write for catalog giving complete range of types and sizes of Hansen Quick-Connective Couplings

THE HANSEN MANUFACTURING COMPANY

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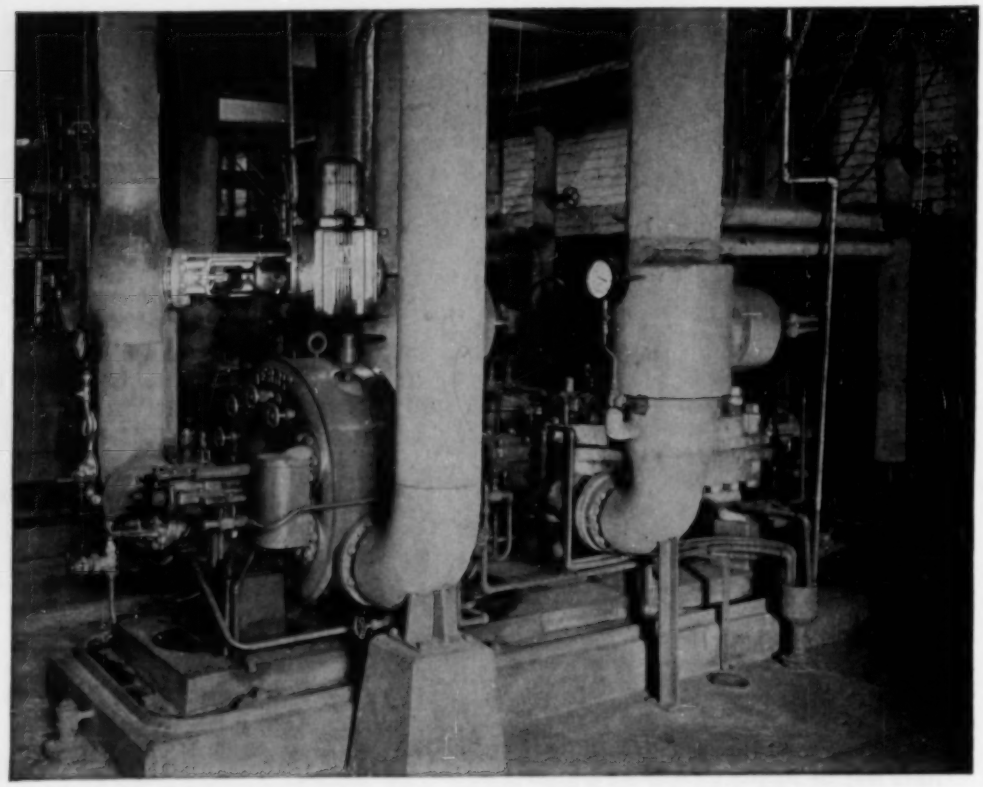
TERRY



This 600 hp high pressure, high temperature Terry Turbine is used to drive a boiler feed pump.

WHY

AMPLE BLADE CLEARANCES ARE SO IMPORTANT

This Terry Turbine has large radial and axial clearances.

If radial clearance should become reduced, the blades are protected by projecting rims at sides.

The side clearance — one inch — is so large that possible end play from excessive external thrust can cause no damage to the wheel. And frequent inspection of thrust bearings is unnecessary.

Write us on your business letterhead for a copy of Terry Bulletin S-116 describing these construction features and other Terry advantages.

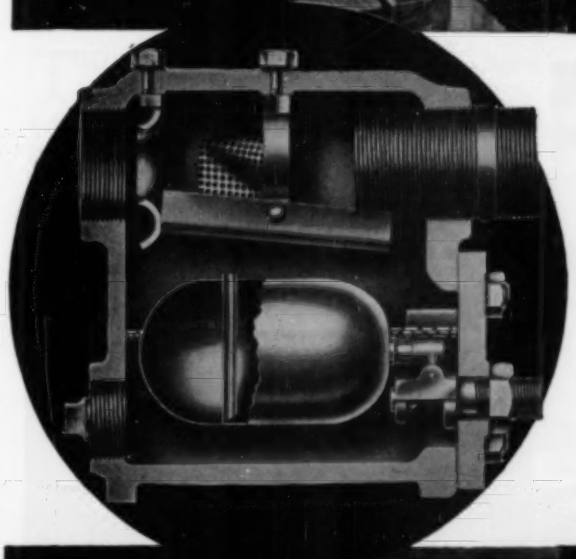
Our district representative will be glad to discuss your specific turbine drive problem with you.

T-1173

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

NO PROBLEM HERE!

with a

SAUERMAN POWER DRAG SCRAPER

In the above picture, iron o e from a refinery is discharged into an areaway between two buildings and a Sauerman scraper, operating back and forth in the areaway, hauls the ore onto an outside storage pile. Another Sauerman scraper aids in loading the stored ore into ships.

★ Many of the long range handling problems encountered in surface mining, pond cleaning, waste disposal, stockpiling, etc. can be quite difficult--but not with a Sauerman Power Drag Scraper. This versatile machine is adaptable to any ground conditions. It digs a heaping load quickly, moves this load at high speed hundreds of feet, dumps cleanly and instantly when its travel is reversed. Precision made to give you years of service with few repairs. First cost is low, too. One-man operation with electric, gasoline or Diesel power. Sizes from 1/3 to 15 cu. yd., spans up to 1000 ft.

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- ☐ Enclosed is (money order) (check) for $.....) ☐ Send books C.O.D. I understand that the books will be sent me postpaid, and that they may be returned within 10 days if not satisfactory.

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Company .....
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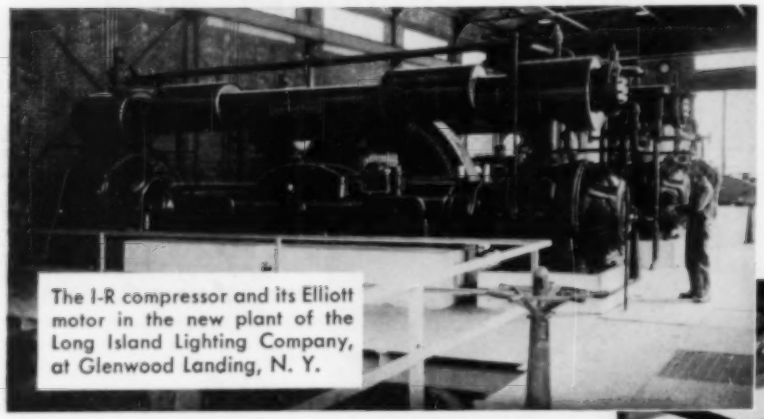
LARGE ELLIOTT MOTOR
...drives gas compressor
for maximum capacity

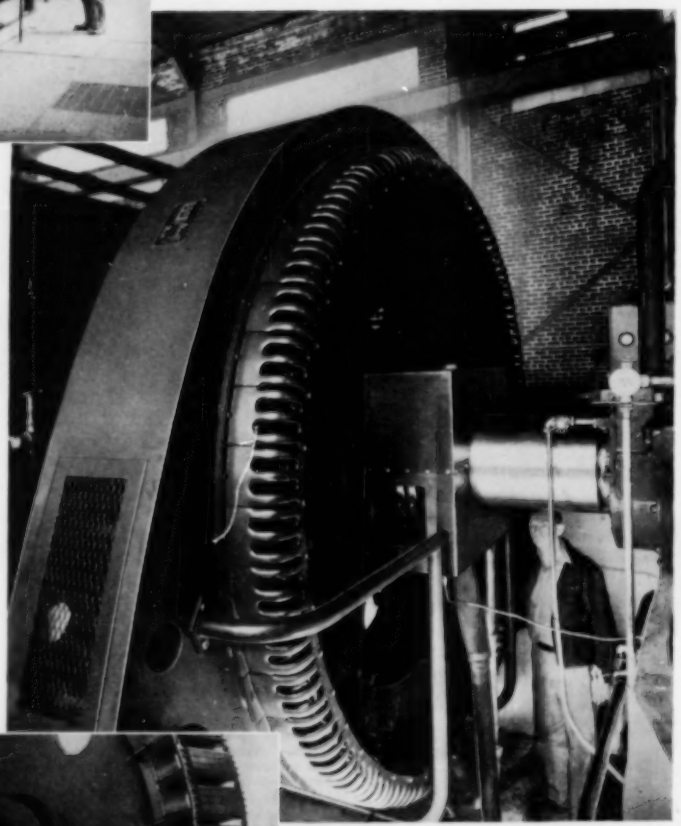


The I-R compressor and its Elliott motor in the new plant of the Long Island Lighting Company, at Glenwood Landing, N. Y.

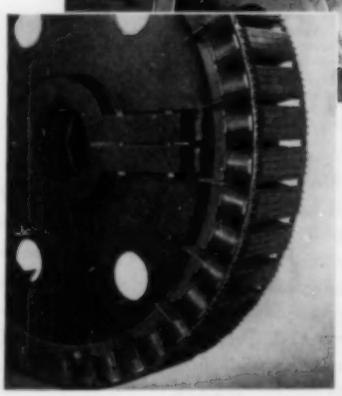
At the new Glenwood Landing (N. Y.) plant of the Long Island Lighting Company an Elliott 2000-hp engine-type synchronous motor drives an Ingersoll-Rand type PRE-2-4C compressor to serve the rapidly expanding needs of Long Island's home developments.

With the flexibility of Elliott "Fabri-Steel" construction, the motor is designed specifically for its job. The rotor is split to permit mounting on the compressor crankshaft, and engineered with sufficient flywheel effect to prevent the reciprocating motion of the compressor from causing objectionable pulsations in the electrical system. Enclosed collector rings eliminate fire hazard.

The many superior construction details of Elliott low-speed synchronous motors are fully covered in Bulletin 5000-2. Address Dept. C.A.



Close-up of the motor, showing explosion-proof, ventilated collector ring enclosure, with lucite windows for visual inspection.



The rotor is of full-split construction, with edge-wound copper strap field coils. Starting winding bars are silver-brazed to the end ring segments for low resistance and for permanent tightness.

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1901 1951

Where TIMKEN® bearings dish it out ...and take it, too!

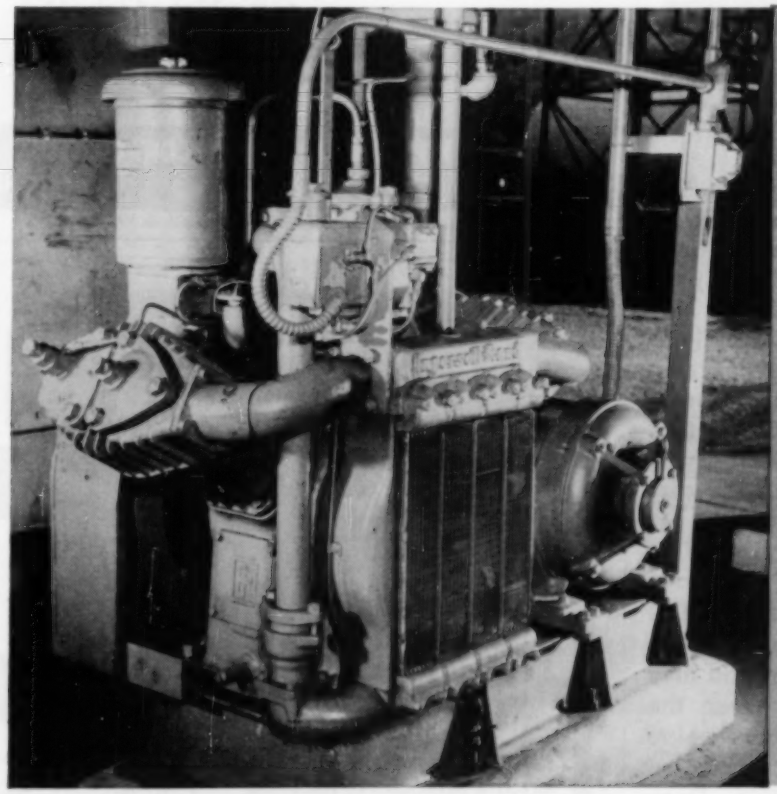
THIS two-stage type 40 Ingersoll-Rand air compressor is in operation at the Bridgeville, Pa., plant of the American Cyanamid Company. It gives control instruments a steady supply of air, day in, day out. To help make possible this continuous service—without costly time-out for maintenance or repair—the compressor crankshaft is mounted on Timken® tapered roller bearings.

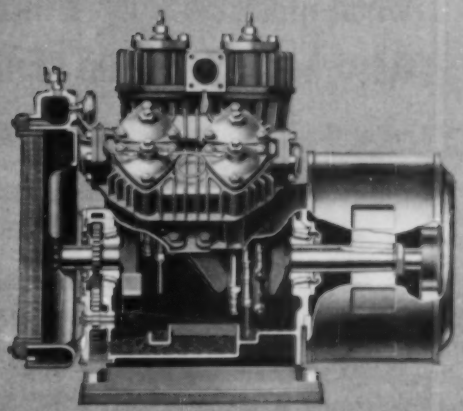
Timken bearings keep the crankshaft in positive, accurate alignment. Deflection and end-play are practically eliminated. Wear on moving parts is cut to a minimum.

Tapered construction enables Timken bearings to take any combination of radial and thrust loads. Line contact between rollers and races gives extra load-carrying capacity. True rolling motion and incredibly smooth surface finish practically eliminate friction. And Timken bearings normally last the life of the compressor.

Only Timken bearings give you *all* these advantages. They're backed by over 50 years of bearing research and development, and are first choice throughout industry. Insist on bearings with the trade-mark "Timken" in the machines you build or buy. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





INGERSOLL-RAND mounts the crankshaft of type 40 compressor on Timken tapered roller bearings. Accurate crankshaft alignment is insured, wear minimized.

FINISHED TO CLOSER TOLERANCES

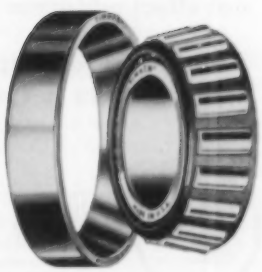
Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

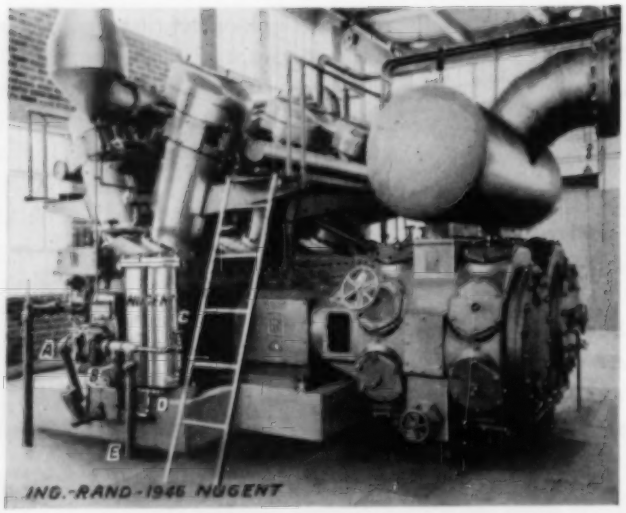
TRADE-MARK REG. U.S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION

Engines . . . Pumps . . . Compressors last longer



when protected by NUGENT Absorbent Type Oil Filters

Longer service life for engines, pumps and compressors is just one of the advantages of protecting this equipment with Nugent Absorbent Type Oil Filters. You save on maintenance, and reduce the amount of costly down-time. Oil costs will go down, too, because Nugent Absorbent Type Oil Filters get 99.8% of the dirt out of the oil enabling you to get more service from your oil.

Nugent Absorbent Type Oil Filters are made in capacities up to 182.5 gpm per container and may be used in multiples. Even the largest size requires only twelve inexpensive replaceable or repackable recharges. Suitable for full flow or by-pass filtering. Does not affect additives in modern compounded oils.

Write for descriptive literature and name of representative nearest you.

Wm. W. Nugent & Co., Inc.
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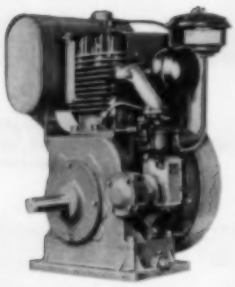
OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Established 1897



Four Single-Cylinder WISCONSIN *Air-Cooled* ENGINES Offering More POWER ADVANTAGE, 6 to 9 hp.

This series of single-cylinder models have all of the traditional Wisconsin heavy-duty features such as self-cleaning tapered roller bearings at both ends of the crankshaft, rotary-type, high tension OUTSIDE magneto operating as an independent unit, and maximum torque at all usable speeds.

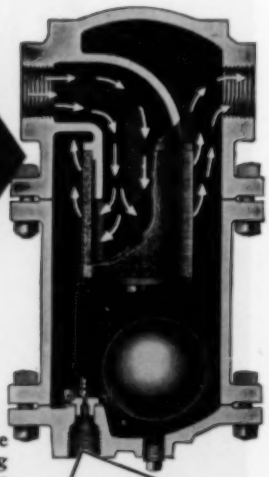
CONDENSED SPECIFICATIONS

MODELS	AEH	AFH	AGH	AHH
Bore - - - - - - inches	3	3¼	3½	3⅝
Stroke - - - - - - inches	3¼	4	4	4
Disp. cubic inches - - - - - -	23	33.2	38.5	41.3
H. P. and R.P.M. range - - -	3.9 at	6.0 at	7.2 at	7.7 at
	1600	1600	1600	1600
	6.1 at	7.2 at	8.4 at	9.2 at
	2600	2200	2200	2200
Net weight in lbs., Standard Engine	130	180	180	180

Our engineering department will gladly cooperate with you in adapting Wisconsin Engines to your requirements. Write for detailed data and name of the nearest Wisconsin distributor.

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 46 WISCONSIN

NO MOISTURE OR DIRT GETS BY HERE



Johnson Self-Draining Compressed Air Separator.....

Like all Johnson Separators the new Type "SA" Self-Draining Separator combines the two most effective principles of removing moisture and dirt from compressed air:

1. Controlled expansion of air in separator precipitates most of the moisture.

2. A "thousand baffles" of coarse mesh repeatedly changes flow of direction to capture remaining foreign matter.

Self-Draining—a simple but complete trap mechanism built right in, automatically drains separator whenever necessary.

Johnson Separation Devices include Separators for Compressed Air or Steam. After coolers, oil absorbers.

WRITE FOR CATALOG

The Johnson Corporation

830 WOOD STREET THREE RIVERS, MICH.

Prolong Tool Life...

With patented ARNOLD LUBRICATORS in your pneumatic tool lines, the flow of "oiled air" to working parts starts automatically when air tool starts, gives you "oiled air" where needed, when needed.

Oil reservoir can be filled under line pressure; pressure-proof window tells you when. Patented adjustable feeder enables you to adjust "oiled air" flow to job needs.

Made of strong, light-weight alloy so they do not drag on line; shaped to prevent catching. No needle valve or moving parts to get out of order. Four sizes. Easily installed. Pay for themselves in repair savings.

→ **Order from your equipment dealer TODAY or write us for leaflet and prices.**

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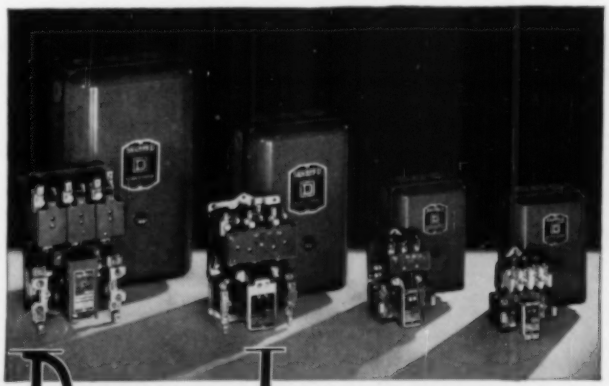
THE RUCKER COMPANY
4228 HOLLIS STREET • OAKLAND 8, CALIFORNIA



DESIGN LEADERSHIP
in
SQUARE D MOTOR STARTERS

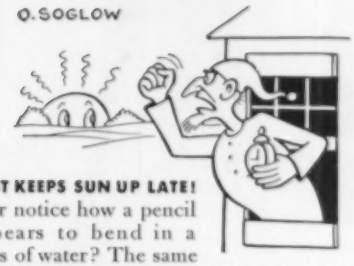
• Generous wiring space . . . simple contact change . . . quick coil removal . . . additional electrical interlocks . . . long life . . . NEMA standardization . . . simplified maintenance.

Write for Bulletin 8536. Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

Ask Your Electrical Wholesaler for Square D Products

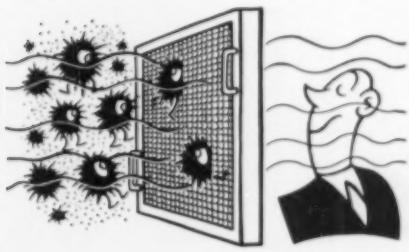
SQUARE D COMPANY
DETROIT • MILWAUKEE • LOS ANGELES

AIR-MAZING FACTS



DUST KEEPS SUN UP LATE! Ever notice how a pencil appears to bend in a glass of water? The same thing happens to light passing through the earth's dusty atmosphere. As a result you can still see the sun after it's below the horizon.

COUNTER ATTACK! Dust falling on counter displays can cost stores thousands of dollars in shopworn merchandise. Leading stores stop dust, dirt and even smoke with Electromaze® electrostatic air filters. File-drawer construction makes installation and servicing easy.



BAD AIR GETS FRESH START! Air-Maze panel filters keep damaging dust and grit out of engine rooms, diesel locomotive cabs, offices, etc. They're all-metal, cleanable, have high dirt-holding capacity and low pressure drop. Available in a wide variety of types and sizes.

WHETHER YOU BUILD OR USE engines, compressors, air-conditioning and ventilating equipment, *or any device using air or liquids* —the chances are there is an Air-Maze filter *engineered* to serve you better. Representatives in all principal cities, or write Air-Maze Corporation, Cleveland 5, Ohio.

AIR-MAZE
The Filter Engineers

AIR FILTERS
SILENCERS
SPARK ARRESTERS
LIQUID FILTERS
OIL SEPARATORS
GREASE FILTERS

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

Life-Lines keep pumps...PUMPING

Nowhere is continuity of service more important than on a central station boiler feed pump. Down time cannot be tolerated. That is why you find so many Life-Line motors on the job in central station industry.

Heavy-steel construction provides the kind of protection against physical damage that only steel can give. Stator windings of Tufvar wire, extra protected by multiple dips and bakes in Thermoset varnish, guard electrical stamina of motors operating in damp locations. Design simplicity results in more trouble-free operation.

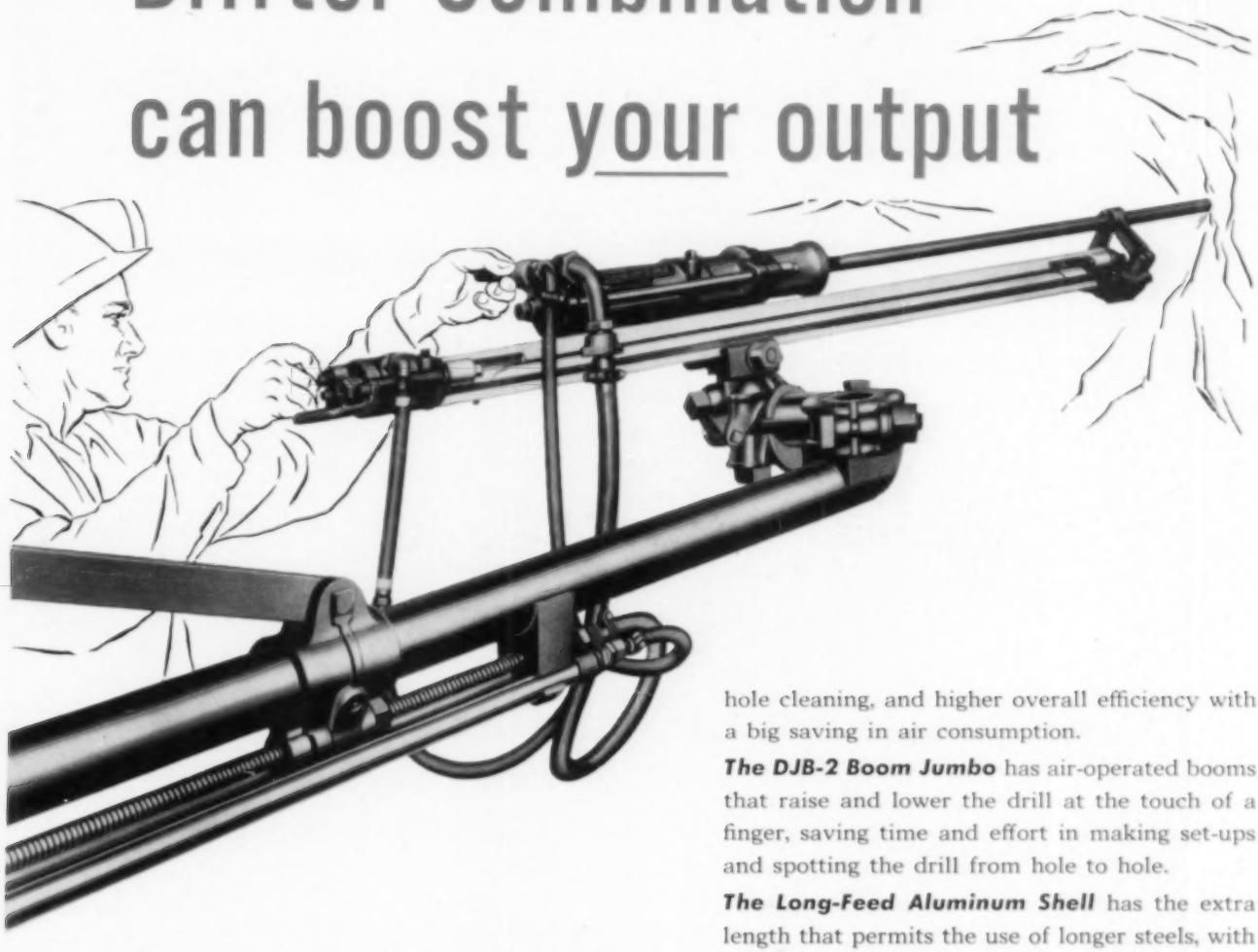
In fact, 500,000 Life-Line motors show a performance record *twice as good* as the best motor we've ever built. That *is* performance, unmatched—the kind you can count on to keep pumps going.

Isn't this kind of performance worth having? Check your Westinghouse representative for further details. Ask for a free copy of B-3842 or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21557

— — If you figure LIFE-COSTS . . . you'll figure LIFE-LINE — —

Westinghouse
Life-Line
Motors
INDUSTRY'S LEADING MOTOR

Here's how this DB-35 Drifter Combination can boost your output



When you combine a 3½" drifter that packs the drilling power of many 4" machines—with an air-powered jumbo that cuts drilling time 33% per round—with a long-feed aluminum shell that permits fewer steel changes—with Carset Jackbits that drill 50% faster—THEN you have an Ingersoll-Rand drilling combination that's sure to boost your output.

The DB-35 Drifter has a new double-kicker port valve that has resulted in stronger rotation, better hole cleaning, and higher overall efficiency with a big saving in air consumption.

The DJB-2 Boom Jumbo has air-operated booms that raise and lower the drill at the touch of a finger, saving time and effort in making set-ups and spotting the drill from hole to hole.

The Long-Feed Aluminum Shell has the extra length that permits the use of longer steels, with fewer steel changes for a given footage. Aluminum construction cuts shell weight in half.

Carset Jackbits not only increase drilling speeds 50% or more—they out perform a steel bit usage by as much as 400 to 1, practically eliminate bit changes, permit use of longer steels, and cut dynamite requirements by as much as 30%.

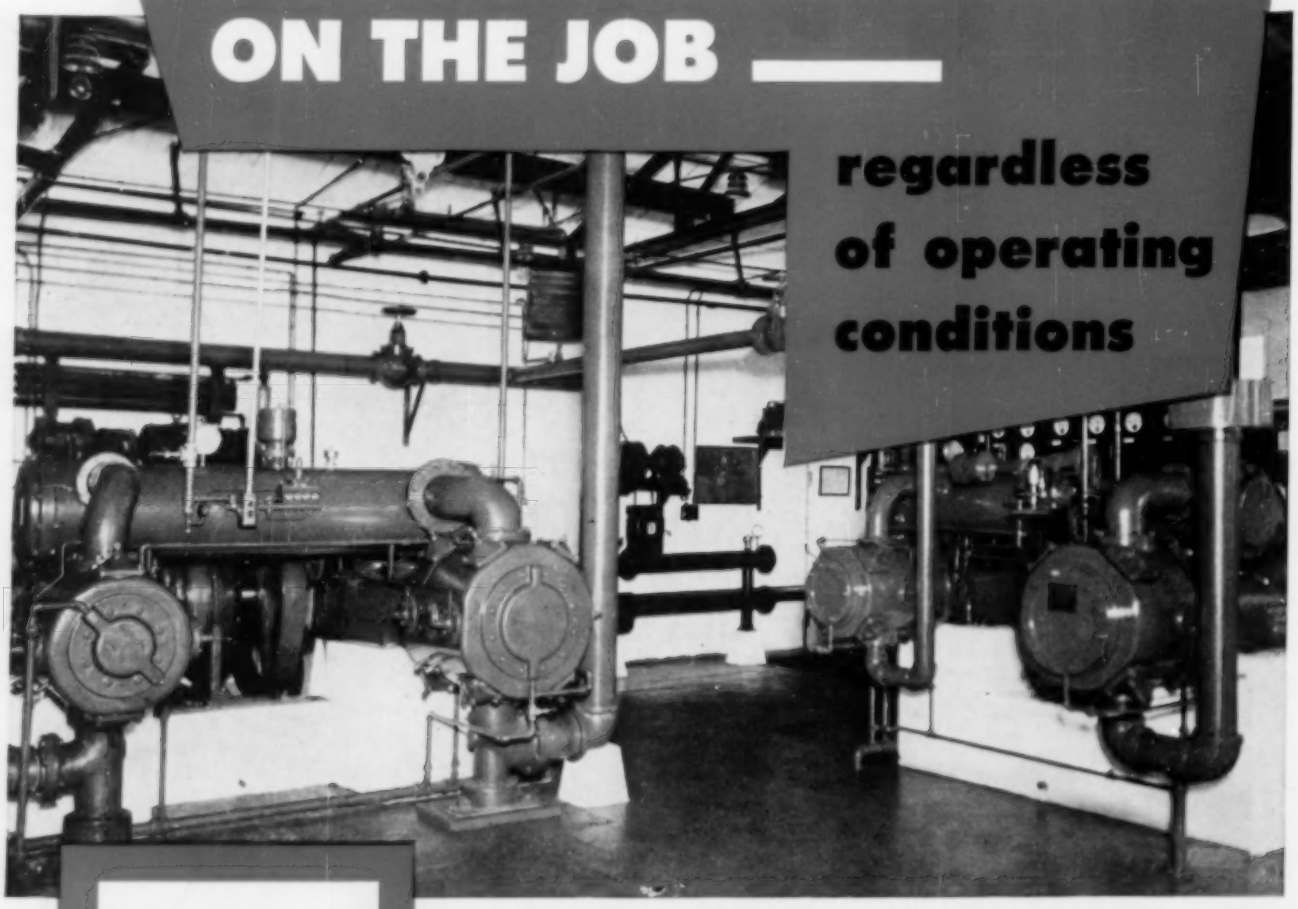
Let our experienced rock drill salesmen tell you more about this I-R Drilling Combination. There's a branch office near you.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 667-5

ROCK DRILLS • COMPRESSORS • AIR TOOLS • CENTRIFUGAL PUMPS • TURBO BLOWERS • CONDENSERS • DIESELS • GAS ENGINES

KEEP AIR COMPRESSORS ON THE JOB —— regardless of operating conditions



DRILLS of all types run better with *Texaco Rock Drill Lubricant EP*. One user states: "We are amazed at the performance of this oil in comparison with what we had been using. We have cut oil consumption 50% and have shown a remarkable reduction in maintenance on all our drills."

. . . with TEXACO air compressor oil

What's the best air compressor oil to keep your compressors working and your maintenance costs low? That depends on your operating conditions. But it *must* be an oil especially designed to meet those conditions. Texaco has it. For example—

★★ To assure clean operation and reduce wear under *normal conditions,* use a Texaco *straight mineral* air compressor oil.

★★ To *overcome rust* conditions in compressors, inter- and after-coolers, lines and receivers, use a Texaco *rust-inhibited* air compressor oil.

★★ To *avoid carbon and gum* formations, use a Texaco *heavy-duty* air compressor oil, with special detergent and oxidation-resistant properties.

★★ To *eliminate excessive wear* caused when moisture condensation in cylinders washes away lubricant, use a Texaco *compounded* air compressor oil.

A Texaco Lubrication Engineer will gladly help you select the one proper Texaco air compressor oil to assure you greater efficiency and lower costs under your particular operating conditions. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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TEXACO Air Compressor Oils

FOR ALL OPERATING CONDITIONS